TECHNOLOGY DEPT:

March 1946

TECHNOLOGY REVIEW

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NON-FERROUS FORGINGS

QUALITY-FORGE

MACHINE-FINISHED

THE HARVEY METAL CORPORATION

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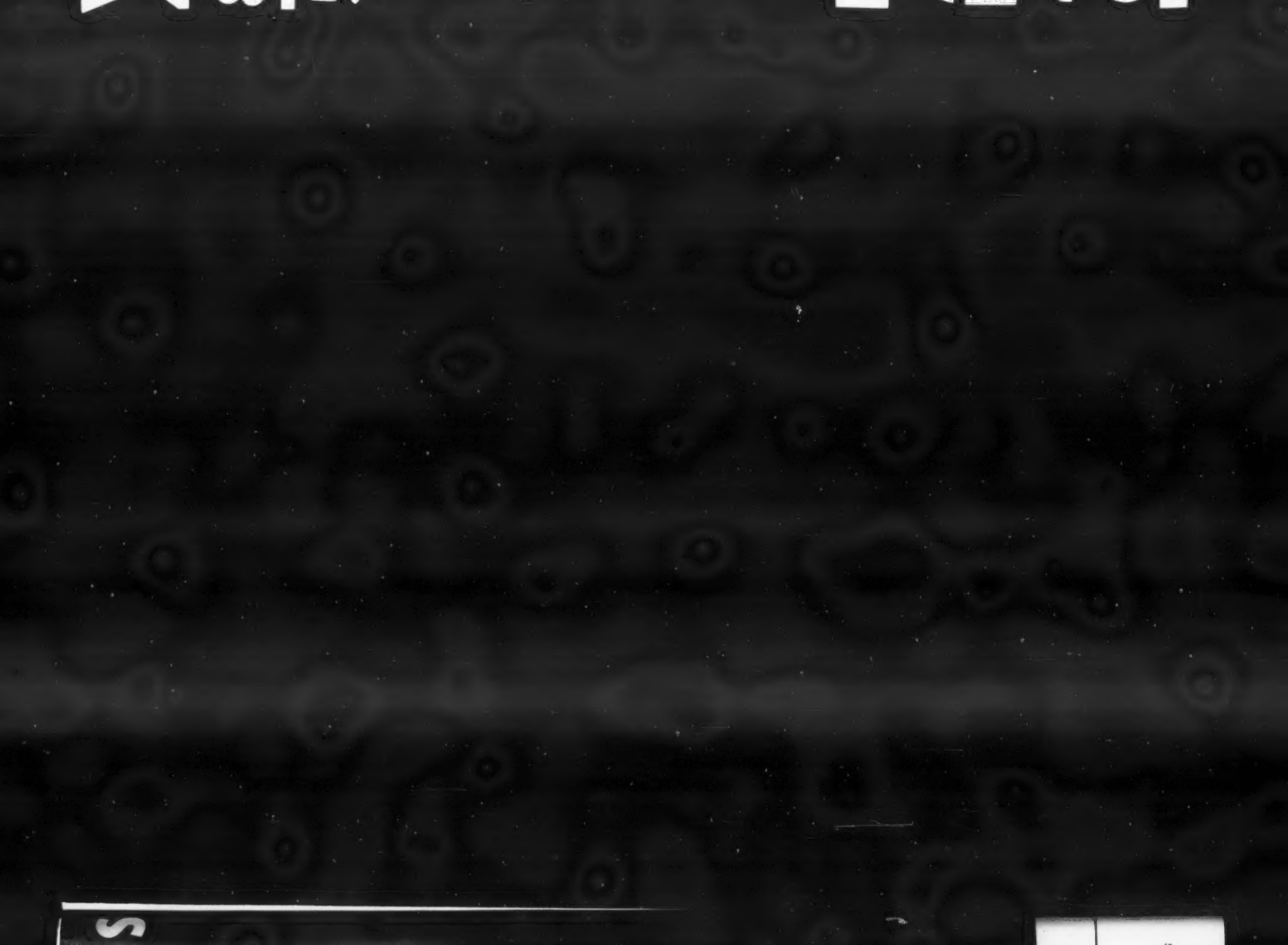
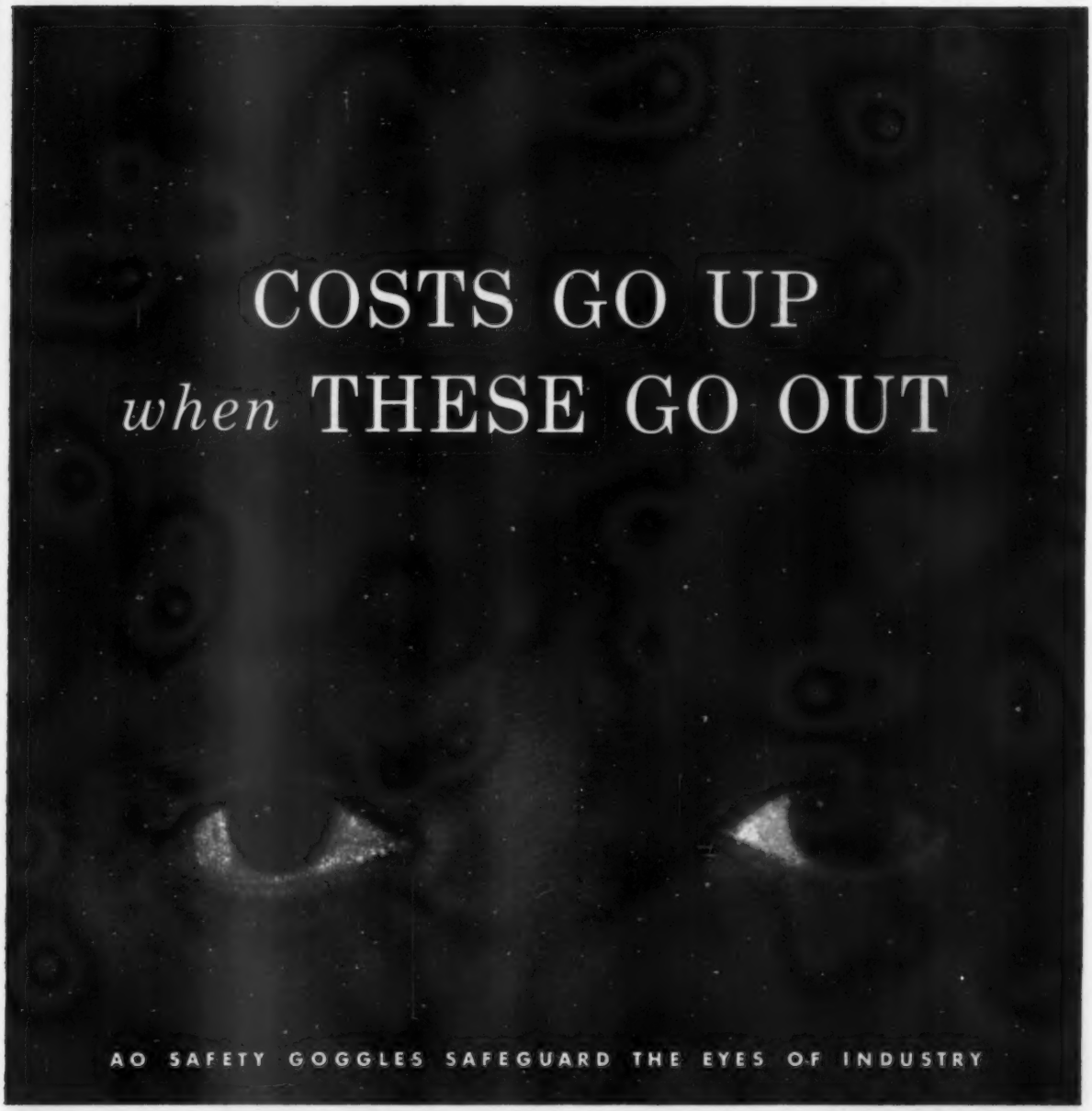
FORGINGS IN ALUMINUM • BRASS • BRONZE • COPPER • MAGNESIUM • MONEL • ALLOYS

MACHINING FACILITIES





EYES are *expensive* targets, for a single eye injury can cost more than $1000 in compensation and medical care.

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Safety Division

THE TECHNOLOGY REVIEW, March, 1946. Newsstand Edition. Vol. XLVIII, No. 5. Published monthly from November to July inclusive at 10 Ferry Street. Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.

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As Architect-Engineer-Manager for engineering, procurement, installation and construction, Badger built this complete 8000-acre explosives plant in co-operation with various military departments of the Government.

Not only the plant itself (process houses, storage, steam and electric power-plant and distribution systems) . . . but roadways, railroads, shops, dormitories, administration buildings, lighting and telephone systems—and a water system large enough for a city of a quarter-million—were Badger-engineered.

The project, ready for operation the day the first unit was completed, was put through with a substantial saving in manpower and critical materials over the requirements previously set as normal for this type of plant.

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It is the sum of diversified and cumulative experience; of large capacity and complete key personnel; of thorough organization and executive control—that enables Badger not only to design, construct and equip chemical or petro-chemical plants of any size and type . . . but to provide auxiliary facilities or utilities as required.

The project described above offers an excellent example of how the Badger method of *unified responsibility* can work toward important advantages to the customer—such as shortening completion time, effecting economies in construction and labor costs, and putting the plant into early and efficient operation.

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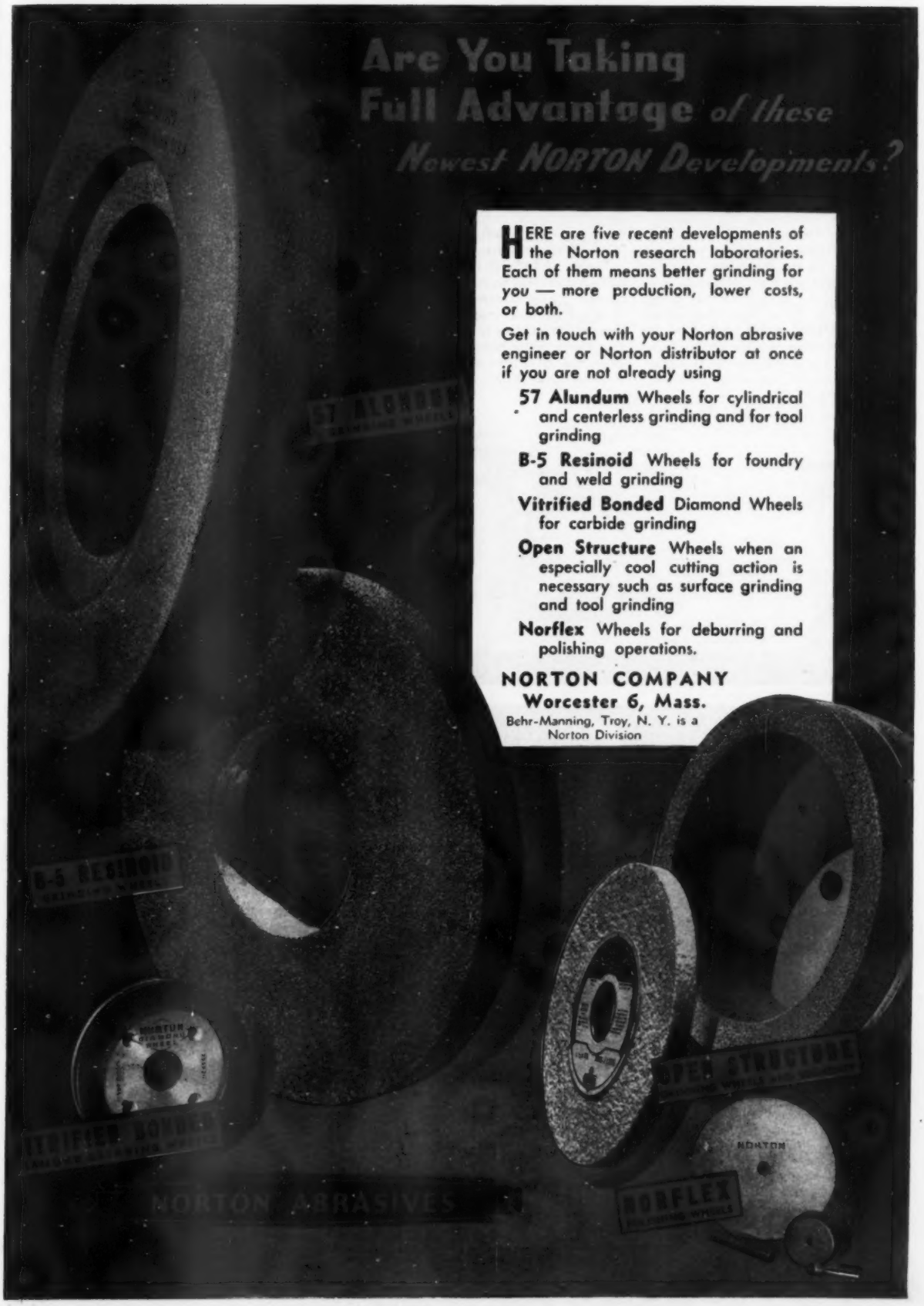
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Delicate machines that draw revealing pictures of heart action... lamps that kill germs... electron microscopes, many times more powerful than optical instruments, that enable physicians to explore new worlds in bacteriology . . . machines for treating deep-seated infections by short wave . . . cool, shadowless light for operating rooms . . .

These, and the developments pictured on this page, are a few of the many contributions of General Electric engineers and research scientists toward helping those who help the sick. *General Electric Company, Schenectady, N. Y.*

Helping fight TB. To quote the United States Public Health Service: "Tuberculosis can be eliminated as a public health problem in a measurable time if we use the x-ray to locate every case in the population . . . and if we provide adequate facilities and personnel to isolate and treat infectious cases." The cut-away picture above shows a mobile unit which can bring chest inspection facilities to schools, industrial plants, and outlying districts far from hospitals. For it, General Electric engineers have designed and built compact x-ray equipment so efficient that as many as 60 people per hour can be examined.

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Machine-made fever. Fever heat helps nature's defensive organisms fight off some diseases. Under the leadership of Dr. W. R. Whitney in the General Electric Research Laboratory, G. E. developed inductotherm machines for hospitals and doctors to produce artificial fever electronically.

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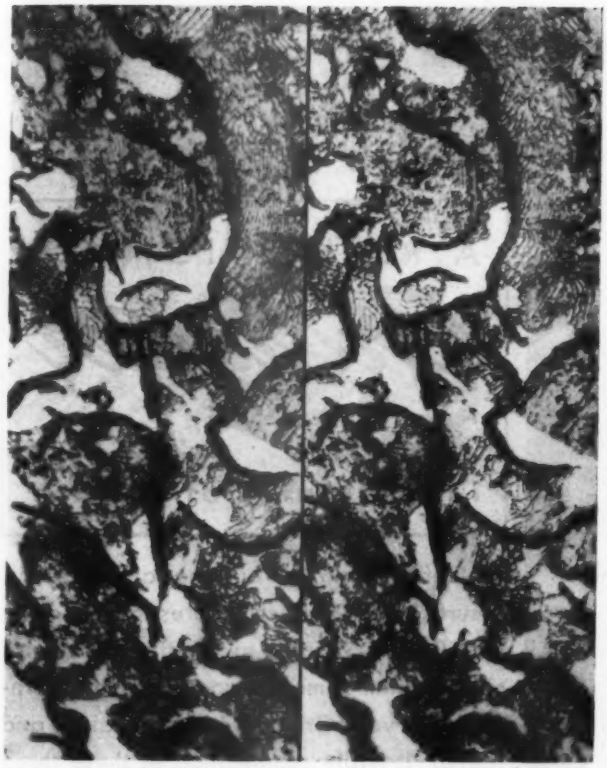

Comparative Photomicrographs of Cast Iron

Left Field, Taken with uncoated 4mm., 0.95 N.A. Apochromat — Flare 20%
Right Field, Taken with Balcoted 4mm., 0.95 N.A. Apochromat — Flare 4.9%

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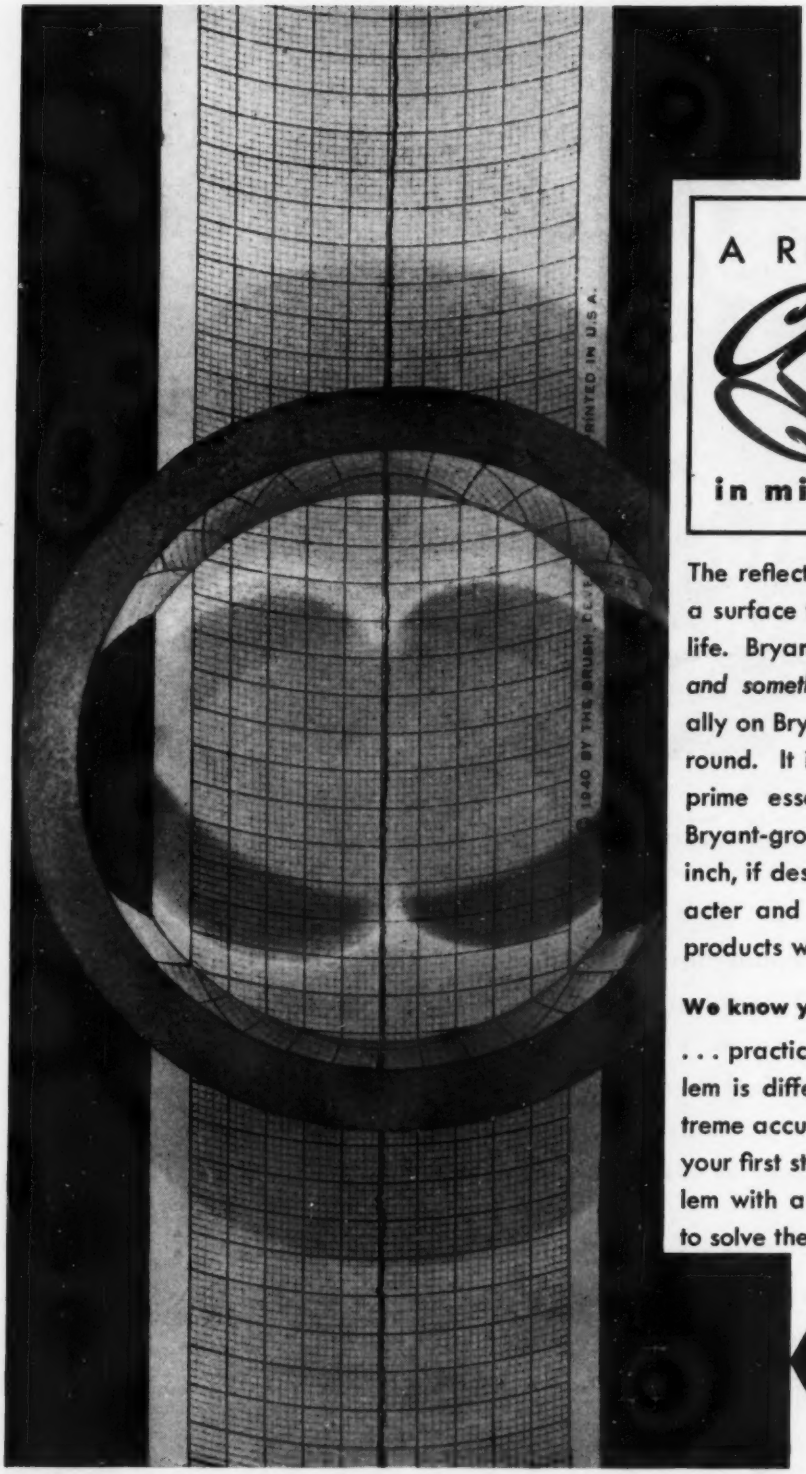

A REFLECTION OF *Character*

in millionths of an inch

The reflection in the bushing, at left, shows a surface finish which assures long bearing life. Bryant Grinders assure fine work finish *and something more*—work ground internally on Bryant Grinders is also straight and round. It is the combination of these three prime essentials that gives character to Bryant-ground parts—in millionths of an inch, if desired. These essentials give character and long life to the assemblies and products which you manufacture.

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. . . practically every internal grinding problem is different, but when you require extreme accuracy or high production, *or both,* your first step should be to study your problem with a man who makes it his business to solve them. Your first step should be to—

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This bushing, with hole ground in a Bryant Grinder, was checked for surface accuracy. The chart line shows deviation. Distance between vertical lines represents one-millionth of an inch.

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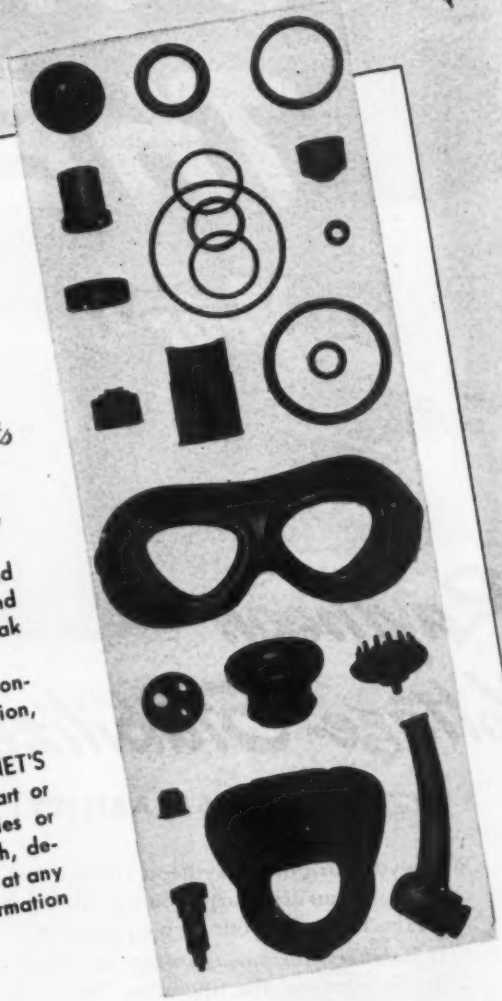

The above group of molded rubber parts only partially indicates the diversity and range of our precision production. If it can be molded of rubber—ACUSHNET will mold it!

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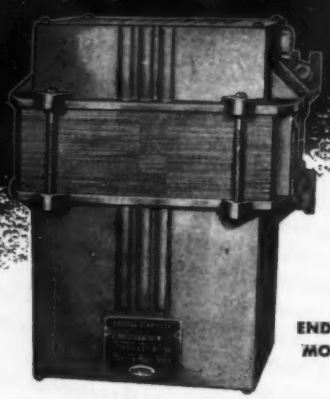

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Raytheon Voltage Stabilizers

INCREASE SALABILITY!

When you build-in a Raytheon Voltage Stabilizer—or offer it as an accessory—you are adding an effective sales feature to your own equipment.

It stabilizes fluctuating voltage to within ±½%. Thus it improves the operation, boosts performance, steps up the accuracy of wide varieties of electrical equipment.

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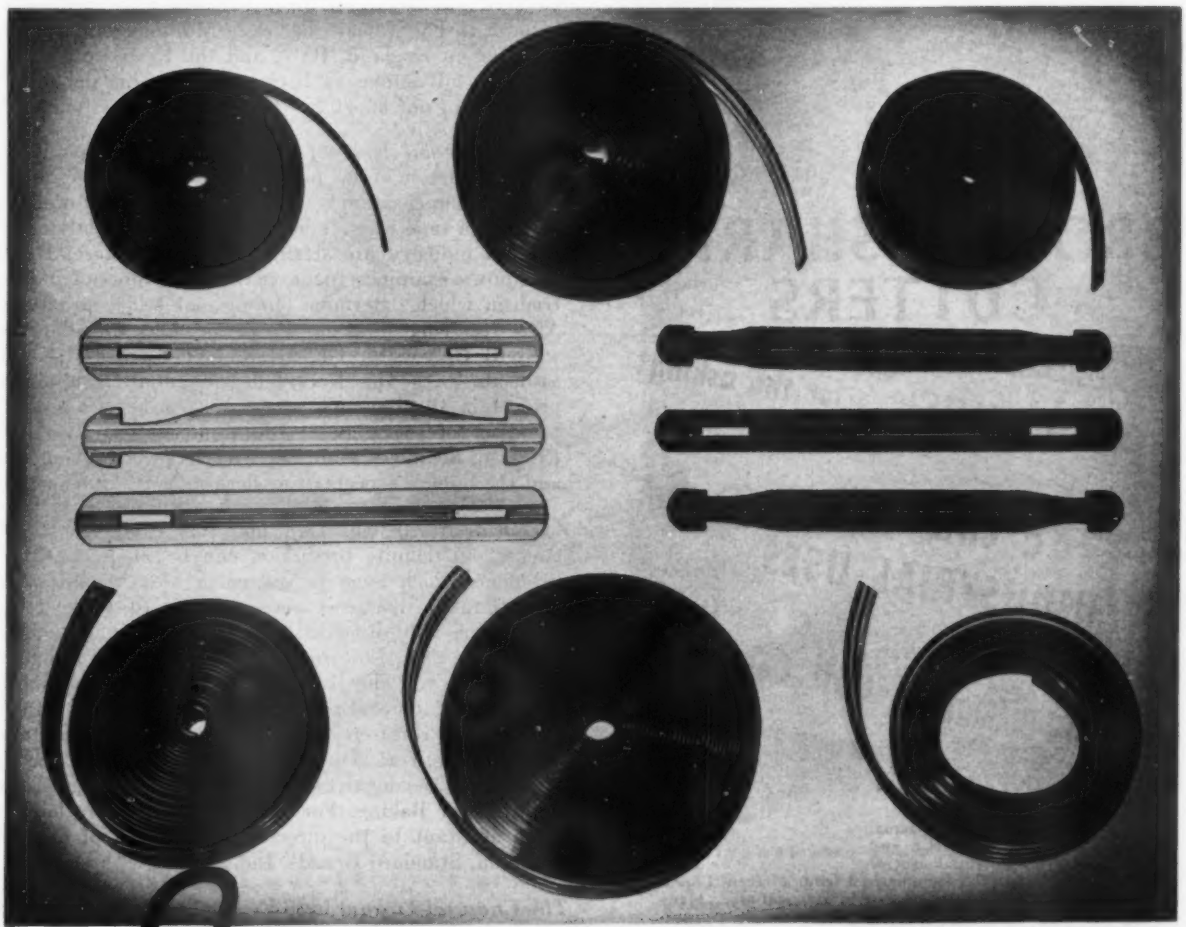

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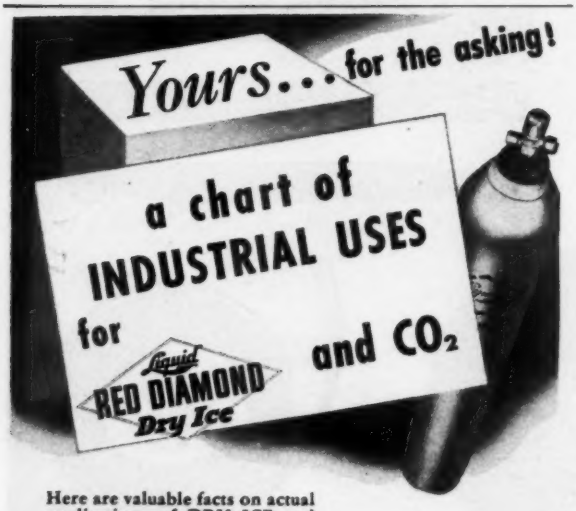

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Use this chart as a check-list for possible applications to your processes or problems... DRY ICE and CO_2 serve industry in many important ways including chilling lubricants, shrinking metals, packaging foods, processing oil, controlling paint quality, etc.

Ask for your copy of this free chart today . . . You'll find it helpful in many ways.

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THE TABULAR VIEW

Bryce Canyon, annually visited by a fair share of this nation's roving vacationists, is illustrated on the Table of Contents (page 277). Submitted with the modest inquiry of our interest in pictorial photographs were half a dozen excellent photographs from STANLEY WITT, who lists himself merely as a reader of The Review. In time, other of Mr. Witt's prints will make their way to these pages. To others who may ponder our interest in illustrations our reply is a definite affirmative.

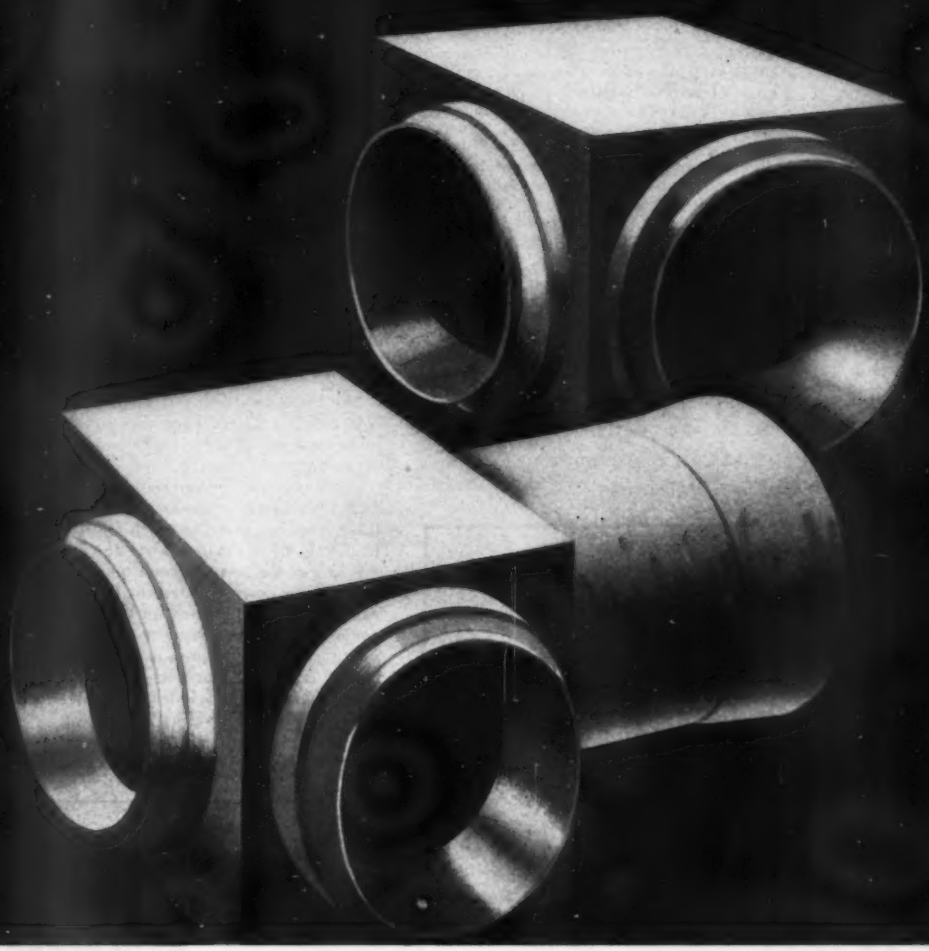
The American Family comes under the scrutiny (page 281) of M. F. ASHLEY MONTAGU, associate professor of anatomy at the Hahnemann Medical College and Hospital of Philadelphia. A thought-provoking writer on physical and cultural anthropology and a frequent contributor to The Review, Professor Montagu employs his residence in England, Italy, and the United States to excellent advantage as background for his delightful portrayal of our effort to "keep up with the Joneses."

The Industrial Way of Life, potentially capable of huge production of low-priced commodities, has exacted a heavy compensation for the benefits it has bestowed on man. At a time when human and economic relations of modern industry are strained as never before, PAUL MEADOWS examines (page 285) the features of industrialism which determine our present social structure. After receiving his doctorate in sociology from Northwestern University, Dr. Meadows became a research associate with the Rockefeller Foundation research project in the humanities. At present he is assistant professor of sociology at Montana State University. Professor Meadows' main interest is in social movements and the human aspects of modern industrialism.

Zenith or Nadir, which will man fully explore first? Of course, no definite prediction can be made, but the problems which must be overcome when man travels even limited distances perpendicular to the earth's surface are ably discussed (page 289) by FREDERIC W. NORDSIEK, '31, Editorial Associate of, and frequent contributor to, The Review. Following undergraduate work in biology and public health, Mr. Nordsiek took up duties as research bacteriologist, executive secretary of the New York Diabetes Association, and later as associate in the department of nutrition of the American Institute of Baking. For the past three years he has been assistant to the director, department of applied research, Standard Brands, Inc.

The Channel Tunnel from England to France has lived through 144 years of dogged proposals without coming to fulfillment or being definitely dropped as impractical. Brought to the fore when the need for transporting liquid fuel across the English Channel became acute during the war, this long planned engineering project is evaluated (page 293) by WILLY LEY, an Editorial Associate of The Review and research worker at the Washington Institute of Technology. Mr. Ley is a prolific writer on topics of engineering and scientific interest.

Good properties from mild quenching make molybdenum steels suitable for bulky, complicated parts.



MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"
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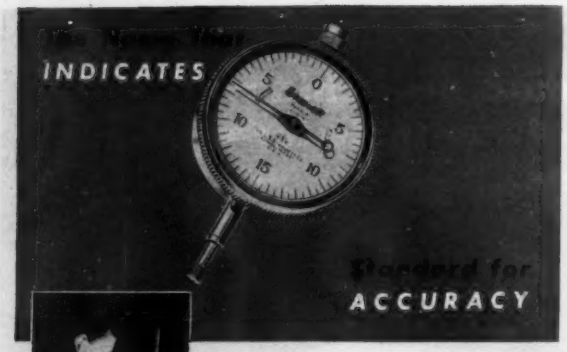

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BATH, MAINE

MAIL RETURNS

Cover Discussion

FROM FRANCIS MARRAN, R.T.3c.:

We have been having quite a few arguments about the cover of the January Review. Perhaps you will be kind enough to settle the dispute for us.

The ship in the picture is obviously an "83-footer," which was probably on patrol somewhere off the coast. The title of the picture, "Through the Maelstrom," would indicate, however, that the ship was operating off the northwest coast of Norway, and to my knowledge no vessels of that type ever operated in that area. If you have any information which would indicate where and when the picture was taken, we would appreciate hearing from you.
% Fleet Post Office, New York, N. Y.

The cover shows a 63-footer (not an 83-footer as mentioned above) photographed during air-sea rescue tests conducted by the Coast Guard in the North Atlantic to determine which ships are best fitted for this type of duty. There is no information indicating in what part of the North Atlantic the photograph was taken. The photograph was released for publication on February 12, 1945. — Ed.

We Blush

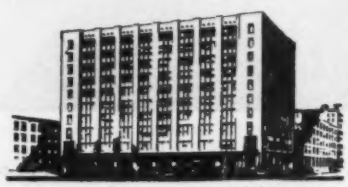
FROM FREDERICK K. MORRIS:

The February number of The Review included a discussion of "The Age of the Earth," in which such serious divergencies from the author's text were made as to reverse the original meaning. I don't seek to place blame for these errors but only to correct them for the sake of your readers; and I beg for space and type for the most essential corrections.

The most serious error is in the last paragraph, page 252, beginning, "We conclude that the earth's history must be composed of three phases. . . ." I did not write these words which reverse the entire meaning of the essay. I won't quote them for fear of driving the error deeper. The correct statement follows: "To calculate the age of the earth we must add the recent 1,500,000,000 years of rock-record, plus a conjecturable billion years of unrecorded history, when the earth was essentially as cool, as wet, as hospitable as it is today, and then a long era of hot-earth years, including gaseous, molten, and warm-crust stages. The formula is indefinite, indeed, . . ." and thence continue as printed.

Other errors which no geologist would like to see under his signature should be noted as follows: (*Concluded on page 310*)

Speed with
Economy



R. C. Williams & Co.

Approximately 70% of our annual business comes from former clients — a continuing evidence of service well rendered.

W. J. BARNEY CORPORATION
101 PARK AVENUE, NEW YORK
INDUSTRIAL CONSTRUCTION
Alfred T. Glassett, '20, Vice President

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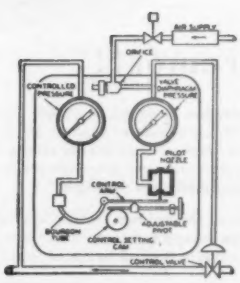
ACCURATE PRESSURE CONTROL AT LOW COST



The Masoneilan No. 2500 Pressure Controller gives plants accurate, dependable instrument control at a price no greater and often at a lower cost than other less efficient methods.

Typical pressure control applications where these controllers are improving quality include — reducing service on primary or auxiliary steam lines, turbine or bleeder make-up, pump discharge pressure control, heating and evaporating systems. The No. 2500 is available for control of pressures between 30 inches vacuum and 500 pounds.

Masoneilan No. 2500 Pressure Controllers are rugged, simple and economical to operate. And although they are relatively inexpensive, they are built to the same high standards of quality materials as all other Masoneilan equipment. Bulletin 2500 gives the entire story. Write for your copy today.

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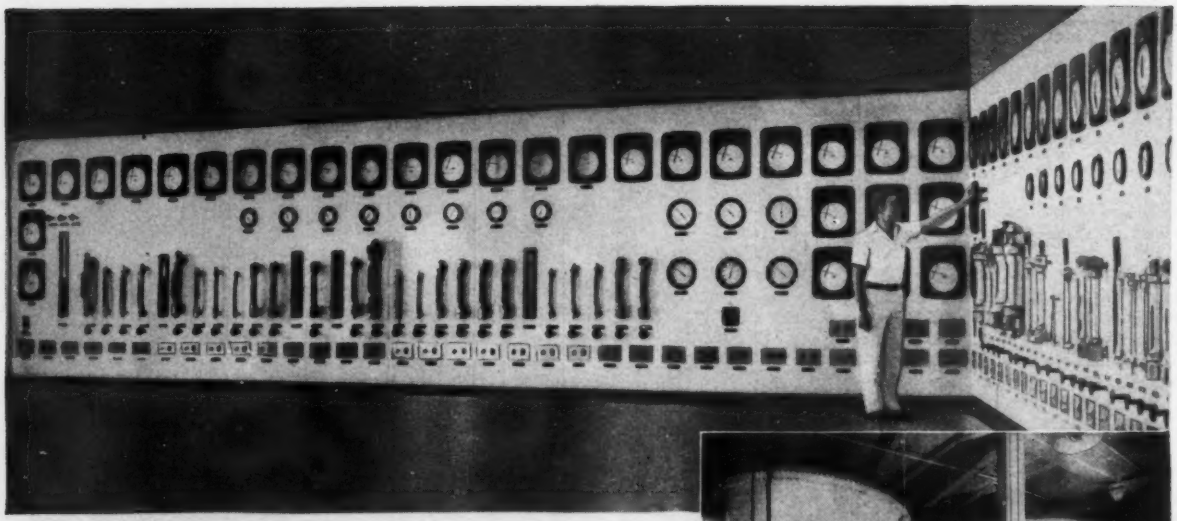
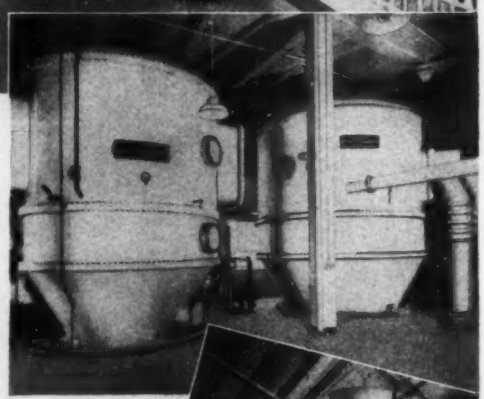
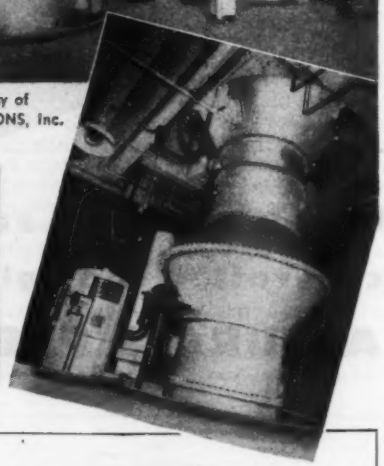






HIGH VACUUM
DISTILLATION UNITS
for the Production of
SUPERLATIVE QUALITY NEUTRAL SPIRITS

Photographs by courtesy of
JOSEPH E. SEAGRAM & SONS, Inc.

Designed and built by

VULCAN

Engineers and Fabricators of

DISTILLATION
EVAPORATION
EXTRACTION

PROCESSES and EQUIPMENT

Quality Foremost!

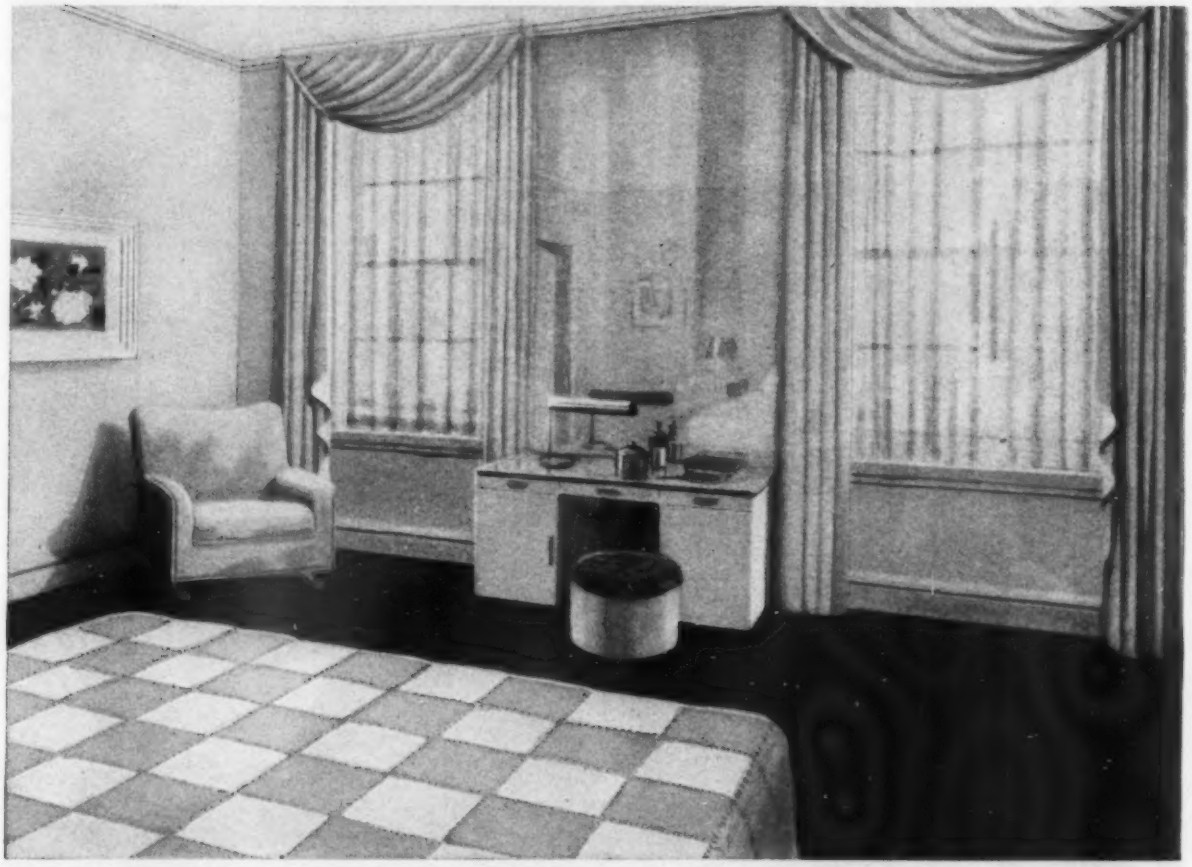
EIGHT YEARS ago the Vulcan organization designed and built the first high vacuum Continuous Distillation Unit for the production of Neutral Spirits. The product obtained from this first unit was of the highest quality ever commercially produced. These results inspired the Vulcan Research and Development Division to seek still further improvements in high vacuum distillation technique.

The distillation units shown in the above photographs, which are now in operation at the Lawrenceburg distillery of the Joseph E. Seagram and Sons, Inc., represent the culmination of these efforts to produce Neutral Spirits of superlative quality.

Vulcan equipment and processes, including the high vacuum spray-type beer stills in which the fermented mash is distilled at room temperature; and the Vapor Re-use method of distillation which effects substantial savings in steam and water requirements, are important features of these distillation units. The super-fine quality of the alcohol being produced is the most tangible tribute to the engineering advances incorporated in the design of this plant.

THE VULCAN COPPER & SUPPLY CO., CINCINNATI, OHIO

Where is the Radiator?

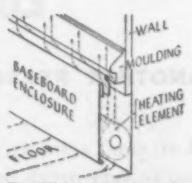


In the Home of Tomorrow the radiator is conspicuous by its absence—it is everywhere, and nowhere. In Webster Baseboard Heating, the heating element is something so small that it fits behind the baseboard and runs in a continuous line all around the exposed walls of the room.

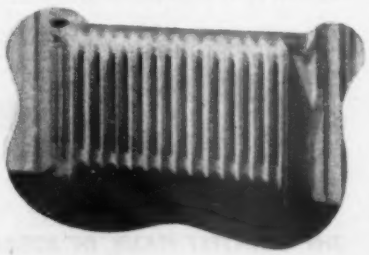
The baseboard unit supplies heat to the room using "forced" hot water. Air goes in at the floor-line, passes over the heating element, is warmed and comes out at the top—a constant, even circulation. No cold corners. No hot spots. No hot-or-cold levels . . . Installations of Webster Baseboard Heating show a variation of less than 2° from floor to ceiling.

With Webster Baseboard Heating there is nothing to limit or mar plans for interior decoration and furniture arrangement . . . And you will find that the absence of radiators in the room gives considerably more useable space.

Webster Baseboard Heating has been under development for several years and has met the most severe operational tests. Deliveries are limited now and will be increased as rapidly as materials can be made available.



The Webster Baseboard Heating Element is copper tubing around which are coiled copper fins. Baseboard Enclosure is removable for cleaning.



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VOLUME 48 NUMBER 5

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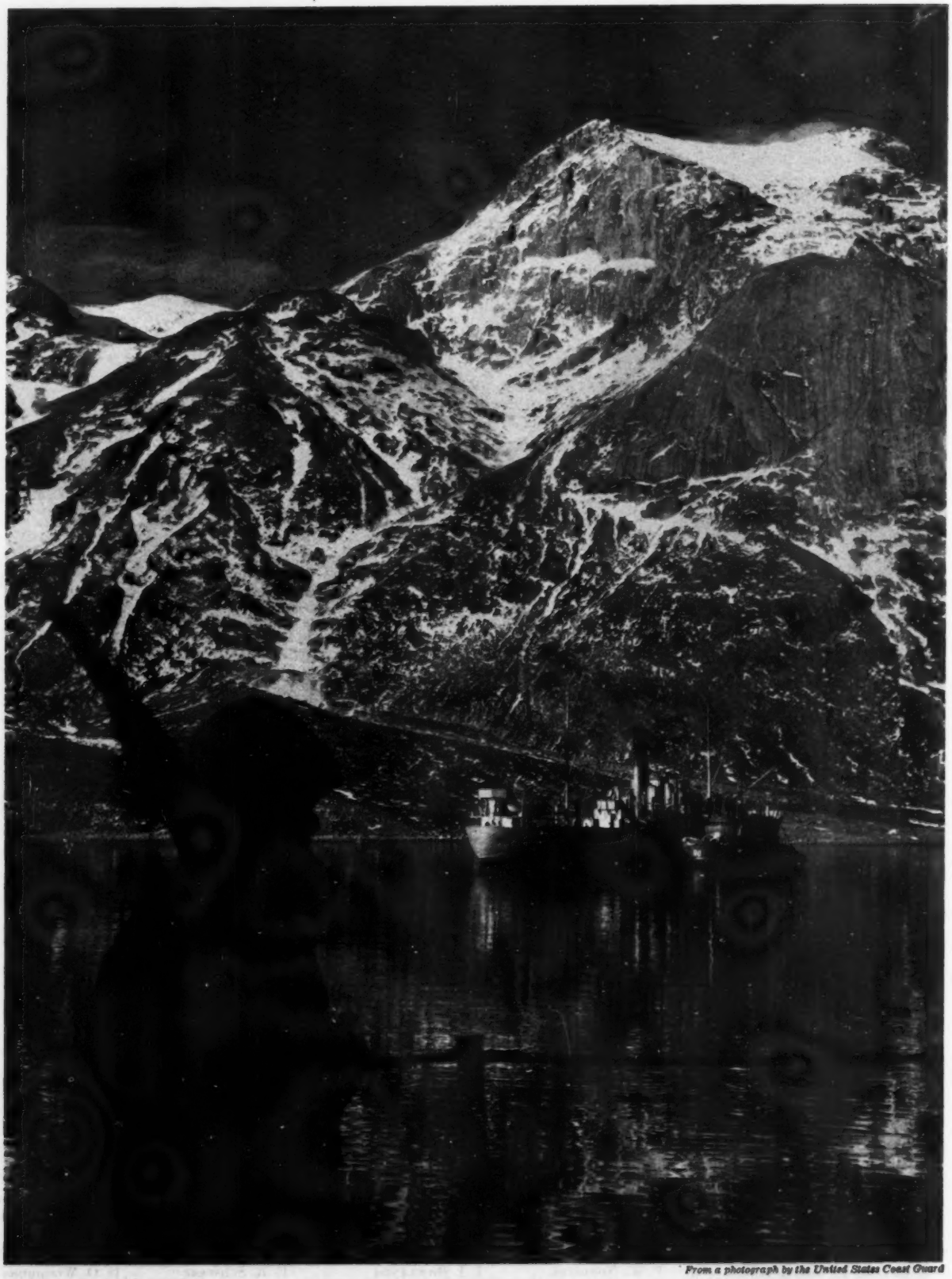

From a photograph by the United States Coast Guard

Arctic Outpost

THE
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March, 1946

The Trend of Affairs

Lunar Echoes

THE distance over which radio communication becomes possible was vastly expanded during Army tests on January 10 when signals from the Evans Signal Laboratories at Belmar, N. J., were received and recorded after having been reflected from the moon. The single pulses, of about one-tenth second duration, which made the round trip between the earth and its satellite in two and a half seconds were limited in the amount of information they could convey, but the reception of a single Morse dot was sufficient to prove, beyond all shadow of doubt, that interplanetary communication is a distinct technical possibility.

The problem of overcoming technical obstacles to make such a feat possible is, in itself, no mean achievement. The peak power of three kilowatts used in these tests was increased to an effective value of 600 kilowatts by means of directive antennas having a power gain of 200. Thus the signals directed toward the moon were equivalent to what might be produced by a dozen of this country's most powerful broadcast stations operating simultaneously. The real achievement in making contact with the moon was not so much the transmission of the signals, however, as the construction of a receiver of exceptional sensitivity and freedom from noise to pick up and record the feeble echo from the moon. The receiver is estimated to have a sensitivity of 0.01 microvolt; that is, it will produce full output with an input signal of 10^{-8} volt. By way of comparison, broadcast receivers are usually limited to a sensitivity of the order of 10 microvolts.

Primary significance of this communication achievement is that the Army tests showed conclusively for the first time that it was possible for very high-frequency radio waves to pierce the electrically charged ionosphere which surrounds the earth and makes possible long-distance terrestrial communication. As if it were impossible to be content with knowledge for its own sake, predictions of practical applications, such as detecting enemy missiles meandering through cosmic space, immediately followed announcement that a dead planet had bounced man's message back to him.

Poor man! He develops wholesale methods of slaughter and retail methods of saving and promoting life. He spends half his time undoing the work at which he toiled laboriously during the other half. He strikes to obtain increased pay to purchase unavailable goods which have increased in price because of higher wages. He devises more and more products, and shortages become more abundant. He ploughs under pigs, burns coffee in time of need, and unites in war to disunite in peace.

If we learn anything by howling at the moon, it is that man can expect to receive only that which he has produced.

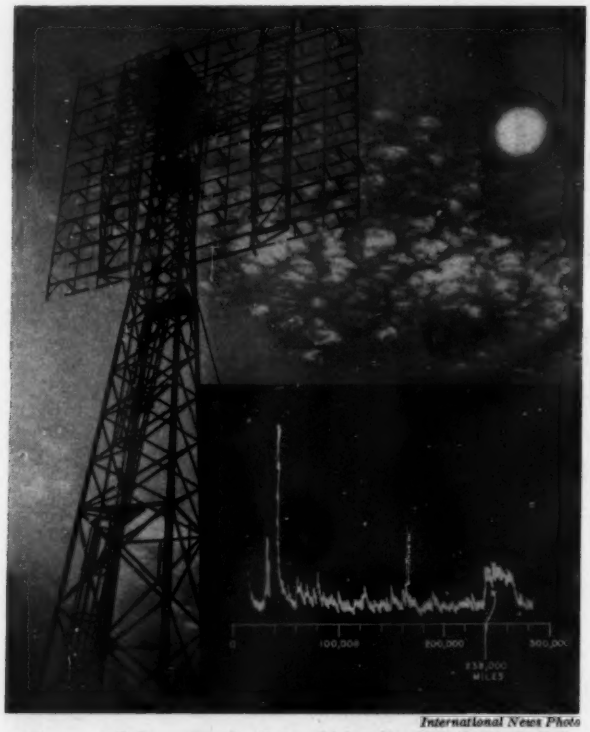
Interplanetary Communication

ALTHOUGH it is difficult to assign a precise date to the first conception of a thought, it seems as though the radar signal shot to the moon did mark the centenary of the idea of communication with other worlds.

Just a century ago the first plan of this kind was published, and its author was one of the greatest figures in the history of science, Karl Friedrich Gauss, the prince of mathematicians.

Gauss's idea was the logical outcome of the astronomical events of the preceding decades: One such event had been the establishment of the true dimensions of the solar system and hence the distance of the planets from the sun and from each other; another had been the discovery of the relative shallowness of the air ocean surrounding the earth (we now know that the atmosphere of the earth extends to less than 1 per cent of the distance to the moon); and finally there had been, in 1822, the discovery of a "walled city" on the moon.

Announced by the Munich astronomer Franz von Paula Gruithuisen, the discovery of the *Wallwerk* ("walled works," meaning place or city) indicated many things,



International News Photo

Tower at Belmar, N. J., from which radar signals made the round trip between earth and the moon in January. The insert shows the oscillographic record of the historic signal. The initial pulse is the faint peak at the zero marker. The reflected echo is indicated by the raised jagged line marked 238,000 miles.

and it made as deep an impression upon contemporary thought as one would expect. The first and obvious indication was that the moon was, or had been, inhabited by beings intelligent enough to have a technology as highly developed as that of humanity of the time of Gruithuisen. In fact, the size of the *Wallwerk* was such as to indicate that the technology of the selenites may have been highly developed, but it might also mean that the moon dwellers were larger in size than inhabitants of the earth.

The fact that the building was a fortress suggested an enemy, either ferocious beasts or, more likely for a multi-walled fortress, a hostile, equally intelligent race. Since the *Wallwerk* was partly destroyed, either the foe against which the walled city had been built had been triumphant, or the fortress had been built so long ago that both hostile races had died out in the meantime, and the destruction had been caused by time and the forces of nature.

All these conclusions would have been perfectly justified if the evidence had been reliable. We now know that it was not. Every astronomer can still see Gruithuisen's *Wallwerk*, but we no longer interpret it in the same manner as Gruithuisen did. It might be said that we don't interpret the "walled city" at all nowadays; it is a strange formation which does not seem to have a counterpart on earth, but its uniqueness does not force us to the conclusion that it is an artificial structure.

In Gauss's time, however, men of science were very much conscious of the existence of Gruithuisen's *Wallwerk*, and Gauss finally suggested sending out from the earth a message which would prove to every intelligent being on the moon or elsewhere that the people of the earth were also intelligent and capable of abstract thought. The nature of the message had to be such that it conveyed beyond doubt two points: that the message itself was deliberate and not an accidental formation and that there was abstract thought behind it. Abstract thought, to Karl Friedrich Gauss, was mathematical thought. Consequently, he suggested a geometrical figure, the "Pythagoras" of the elementary textbook, the right-angled triangle with a square over each side.

Such a figure could not have been an accident of nature, and its meaning should have been clear to every race in the universe which had begun to think. In finding a way to send the message, to construct a "blackboard" of sufficient size, Gauss pointed to the Siberian tundra and suggested a pattern formed of dark pine forests and yellow wheat fields. The three sides of the triangle were to be six, eight, and 10 German miles long (the German mile is 7,500 meters or about 24,600 feet long), and each line a German mile wide. The lines were to be pine forests, and the area of the triangle and the squares, or of the squares alone, was to be seeded with wheat.

Such was the message to other planets proposed a century ago, a feat of considerable ingenuity and certainly possible of fulfillment even with the most primitive means. If Russia had had at that time a ruler interested in science, as it frequently had, means for sending the Gauss message would probably have been built.

Some time later, the astronomer Littrow of Vienna adapted Gauss's proposal to the Sahara desert. He proposed a set of trenches, one circular, one square, one hexagonal, one triangular, and so forth, which were to be filled with water. Then enough kerosene to burn for perhaps six hours was to be poured on the water, and one trench was to be illuminated one night, the other the following night, and so forth, the end of the succession to be celebrated with the illumination of all of them.

Although Littrow's scheme was still sensible and possible, another one, advanced by the Frenchman Charles Cros in 1869 was plainly fantastic. Cros wanted to construct gigantic shallow mirrors and use them to fuse the sand of the Martian deserts to gigantic figures, proving the intelligence of the terrestrials in various ways at once. He neither worried too much about the technical impossibilities of creating and guiding mirrors of such size, nor did it occur to him that the Martians might feel attacked and retaliate.

Later, when photography became common, an English engineer suggested that large quantities of flashlight powder be used for signals to other worlds. Enough was known by then to realize that the atmosphere of the earth would be highly detrimental to the project. (It would make Littrow's suggestion useless, too.) For this reason the flashlight powder was not to be exploded on the ground but was to be carried up first by captive balloons to the highest altitude to which these balloons could possibly rise. Even with that added refinement the amount needed would still be on the order of a few carloads to attract the attention of the Martians.

Of all the suggestions advanced during a full century of speculation, the first proved to be the most logical and least expensive. But even Gauss's Siberian tundra blackboard would have been of any use only under the assumption that there was somebody to answer at the other end of the line.

The American Family

Ever Striving for Bigger and Better Things, the American Family Is Apt to Break with Tradition and Place Greater Emphasis on Its Physical Rather Than Cultural Possessions

By M. F. Ashley Montagu

Ewing Galloway, N. Y.

Symbolizing the pioneering spirit, respect for the dignity of man, pride in one's work and integrity, and rise to high position from humble beginnings, the Great Emancipator has had profound effect on the boys of American families.

THE family is the social institution which is developed around the child-mother-father-sibling relationship. It is within the organizing field of energies constituted by this institution that the child first learns to become a human being, a social being. As a result of the interaction between himself and the socializing conditions of his particular family the foundations of his character and personality are laid. If we are to understand that part of the American character which is an expression of the socialization process within the family, it should be obvious that it is necessary to understand the structure and functioning of the American family.

At the outset we must recognize an important fact: The American family neither possesses quite the same structure nor functions in quite the same way in different classes. The differences are appreciable and significant, and their effects upon the social development of the person are important. In fact, the effects of these differences play a very considerable role in determining the character and basic personality structure of the person in American society. With this thought in mind, we shall deal with the process of socialization in the typical urban middle-class family.

The ethos of the family is determined by the ethos of the society as a whole; this relationship is clear since the socialization of the child within the family is calculated to be a preparation for life in society. In a very definite sense, the family is a minuscle reflection of the aims and ideals of the society of which it is a part. The dominant aims and ideals which prevail in any society are those with which parents endeavor to equip their children. But we are not so much concerned here with the process of this equipment as with the effects of the actual functioning of the American family upon the development of the character of the American.

In the case of the American family we occupy an enviable position in being able to trace the antecedent conditions which have produced its peculiar structure. The conditions of life on this continent have molded the unique development of society and the family. The frontier spirit of exploration, adventure, individualism, and progress, the measure of a man's worth in terms of achievement and economic status, the movement onward to better and greater things, the breaking with the past — all of these make up "the American way" and have a tremendous influence on the American family. In keeping with this spirit, parenthood in America, as Margaret

Harold M. Lambert

The American father tends to be gentle and helpful; he is apt to be generous, sympathetic, and a good mixer.

Mead has pointed out, has become a very special thing. ". . . parents see themselves not as giving their children final status and place, rooting them firmly for life in a dependable social structure, but merely as training them for a race which they will run alone." [1]

The American parent is bent on seeing that his children go places and do things, that his children will go to better places and do bigger things than he himself did. In no other land do parents do as much to make their children happy and successful as in the United States. Sensitive foreigners never fail to comment upon the fact that children in America are so much happier than those in Europe. As compared with Europe, here there is a greater freedom from parental over-discipline and a much greater freedom to behave as a person in one's own right. These forms of behavior are not unrelated.

But let us now briefly consider the structure of the American family.

In other societies the family is a common enterprise of mother and father. In America there is an asymmetric segregation of the roles of mother and father in which by far the greater part of the socialization of the child falls to the mother. The father's principal role is extra-familial. Although his part in the socialization of the children is not an extended one, in terms of temporal duration, it would be a grievous error to suppose that it is a minor one. To him, the family is very much more than a refuge in which he relaxes from the rigors of the masculine occupational world. It is a refuge, of course, but it is also a great deal more. There is no Western society in which the father is more devoted to his children and kinder to his wife than in the United States. It is, however, equally true that in no other society is the father so freely willing to transfer the greater part of the upbringing of the children to his wife. This fact is illustrated by the story of an American who introduced his children to a friend with the words, "George, meet my wife's children." The fact that a Hollywood script writer put this remark into a film scenario indicates that it was meant to strike a responsive chord, and it did. Another story tells of the inquiring observation made by a child to its mother concerning its father, "Mummy, who is that man I see around the house on week ends?"

That the father is present so much less than the mother and that he is likely to be the very much weaker disciplinarian, the weaker socializing agent, have very important implications for the development of the American character. In the first place, the emotional bonds are generally very much stronger with the mother than with the father. Mother's Day is not merely a tribute to the weaker sex, for Americans don't believe in a weaker sex. A peculiar American phenomenon which has been called "mommism" is the sentimentalized attachment of the male particularly to "mom." In an extreme form, mommism becomes ludicrous as is illustrated by the hulking brute of a boxer who stertorously breathes into the microphone: "Hello, mom, this is Bruiser. It was a good fight, an' I won. See ya soon, mom."

The attachment to the mother is indicative of the importance of her role in forming the character of the child and has one very significant influence upon American character on the whole. Through its influence the American develops a certain number of traits which Europeans regard as primarily feminine. Europeans describe these traits collectively under the term "softness" — the softness of the female as compared with the "hardness" familiar in European males. The American male tends to be gentle, kindly, and helpful; he is apt to be generous, sympathetic, and a "good mixer." European women who know America agree that American men make the best husbands in the world. They do not feel that American men compare too favorably with European men intellectually, but they are convinced that men in the United States are easier to live with and are more co-operative than European men. In brief, I should say that this dissimilarity between American and European men is a

[1] Margaret Mead, *And Keep Your Powder Dry, An Anthropologist Looks At America* (New York: William Morrow and Company, 1942), p. 41.

function of the amount, kind, and source of the love which they receive in childhood.

The tenderness of the American male is something of which most American parents are aware. It seems to me that the parents' anxiety that their boys should not develop too much in the direction in which their daughters are encouraged to develop is reflected in the family's overemphasis on toughness. There is a feeling that a boy ought to be tough. "Don't be a sissie," is the kind of thing more often heard in this country than in any other. It is not that parents want their boys to be tough, but they distinctly do not want them to be soft. From early childhood a double influence, originating chiefly from the mother, operates upon "Junior." These two forms of socializing include a goodly amount of mothering on the one hand and, on the other, those influences and rewards which are calculated to make Junior a little man.

Becoming a man, growing up in terms of the American creed, is measured in terms of achievement, which means competition. You must run better, skate better, play better, get better marks, eat better, get there faster than anyone else does. You must advance. Getting ahead is the great object in life of American Juniors. Getting ahead, Junior learns, is the principal means of retaining the love of his parents, particularly of his mother. He feels that his parents' love is conditional upon how he compares with and measures up to others; he must compete and be successful. Becoming a man means being a success, and so the parents and Junior can hardly wait for the time when they can decently put him into long pants. The United States is the one place in the Western world where boys not yet in their teens wear long pants.

Girls, of course, are also affected by this drive pattern, and by the time they are halfway through high school, painted fingernails and lips and most of the other signs of technical adulthood have been adopted. The female, too, is judged in terms of comparison with other females. As one of the most conspicuous methods of calling attention to her achievements, the American female indulges in external attractiveness. The average American middle-class female dresses as well and as expensively as do only members of the upper classes of Europe. The lower-class American female dresses more attractively than the European middle-class female. In no European land is the principle of conspicuous display as significantly symbolized by the mink coat as in America.

It is not so much that the male regards his wife as a means by which he can demonstrate to the world his own successful achievement as that the female uses her husband's money to demonstrate her own successful achievement. To succeed, a woman must make herself attractive, and here again the drive is tremendously strong, even if emphasis is placed on external superficialities. In no other land have beauty parlors, Madame Rubinsteins, and Elizabeth Ardens become the institutions that they have in this country. Beauty is big business. The charms of the female are everywhere, but nowhere else have they become so aggressively competitive in the open market as in America. It was in America that women first took to bloomers, first dared to raise their skirts above the ankle, and first abandoned the "bathing costume" for the kind of beach clothes they now affect.

Women are not any more sexually endowed in America than they are elsewhere in the world, but the great American spirit of competition has affected them no less

Harold M. Lambert

The American parent is bent on seeing that his children go places and do things, that his children will go to better places and do bigger things than he himself did. There is no Western society in which the father is more devoted to his children and kinder to his wife than in the United States.

than it has the male. The girl must make a better marriage than her mother did, she must move on and ahead. Hollywood interprets the pattern for her by the time she is old enough to go to the movies. There the girl always marries the man of her dreams; the poor girl marries the rich man's son, the rich girl marries the poor but promising youth. These fairy tales satisfy the masses; the noble poor girl steps up and Hollywood's rich youth buys her a mink coat and a Deusenberg; the pampered rich girl steps down and her dream youth steps up, and everyone lives happily ever after. The youth looks like Clark Gable, and the girl like Katharine Hepburn, Ingrid Bergman, Veronica Lake, or Betty Grable, preference being given, as it seems, to a standardized type of mediocre intellect, education, and culture, if we are to judge by recent movies.

To the European, American aggressiveness is puzzling and distasteful, and "the dependence upon externals for the validation of success" (Mead) appears childish. To the European, the American, with his tremendous impetus to obtain renown by achievement and his hunt for status, seems to sell his birthright for a mess of prestige.

The American's admiration for big things — for size, magnitude, quantity, the tallest buildings, the largest planes, the longest roads, and the most money — reflects the nature of his scale of achievement. He must excel; it is "the American way."

Obviously, there is a very definite and a very clear relationship between the emphases of the American's socialization process and the nature of his character drives.

Harold M. Lambert

In a sense, the American never really grows up; he never grows beyond the ideals which were patterned for him as a child; the male remains an overgrown boy. On the other hand, the American father is looked upon as a friend by his children from their earliest years. Altogether there is a kindly affect associated with him.

Compared with the European father the American father is a negative quantity. Although the European father may be away from home quite as much as, if not more than, the American father, he is nothing like the *pater absconditas* that the American is. The image of the European father is very strong, that of the American comparatively very weak. In Europe the mother uses the father as a sort of bogeyman with which to threaten the children: "Father won't like that," or "Wait 'til your father comes home." The father in Europe is feared; one goes in awe and respect of him. The next thing to the power of the deity is the power of the father; by the middle of his adolescent years an English boy, for example, is referring to his father as "the old man," a phrase which perfectly defines all that is patriarchal.[2]

On the other hand, the American father is looked upon as a friend by his children from their earliest years. Often he is the intermediary who tries to soften the disciplinary behavior of his wife toward the children. His own disciplinary conduct as a parent tends to be kindly. The children can argue with their father, and he will often admit that he was wrong and apologize to them. Father gives them an enormous amount of freedom, and everyone knows that he is a much easier mark than mother. Nevertheless, he can also make things very difficult by withholding his approval and his money. But altogether there is a kindly affect associated with him. There is very little conflict with him, and he does not constitute a competitor. The Oedipus conflict can scarcely be said to exist in the American family. Father isn't a rival, rather he is a friend. The image of authority is a reasonable one. It is very probable that this peculiar child-father relationship explains that striking difference between European and American culture which can be summed up in the words, "In America you can argue with and bawl out the umpire — in Europe you never can." It explains the comradely feeling of American soldiers for their superior officers and the protective, benevolent attitude of the officers to their men.

This peculiar attitude toward the image of authority was interestingly exhibited during the first few days following the death of the late President Roosevelt. Many Americans felt as if they had lost a protecting father; in some cases, the loss was felt as if a member of one's own family had died. The President was not regarded as an awesome, unapproachable ruler, but as a kindly, helpful, guiding father, a person upon whom one could rely for a steadying hand and at the same time with whom one could crack a joke. In czarist Russia the czar, *batoushka* (a very intimate term for father), was similarly regarded by the peasant, but one could most certainly not crack jokes with him; there was enough of a consciousness of his autocratic role effectively to prevent that.[3] The rulers in Germany and England are not regarded as kindly fathers. The image of the reigning leader or monarch is patterned on the image of the father.

Sibling rivalry in the American family is also weak, for, as Mead points out, such rivalry is directed to success in the outer world, in contradis- (*Concluded on page 308*)

[2] See the classical study by Sir Edmund W. Gosse, *Father and Son: A Study of Two Temperaments* (New York: Oxford University Press, 1934).

[3] The resemblance between American and Russian family structure is striking. On the congeniality of the American and Russian personalities, see Pitirim A. Sorokin, *Russia and the United States* (New York: E. P. Dutton and Company, Inc., 1944), p. 55.

The Industrial Way of Life

An Increasingly Abstract and Impersonal Pattern of Living is the Price Which Industrialism Has Exacted for the New Inventions and Wealth with Which It Has Endowed Human Life

By Paul Meadows

INDUSTRIALISM functions as a way of life — as an over-all pattern which arranges for a people their technics and relationships into a relatively satisfying design for living. Except for the flint-tool economy of early man, industrialism is the most widely spread culture in human history. Nevertheless, as a culture system it is less familiar to sociologists and anthropologists than many of the so-called simpler cultures.

The focus of any culture tends to be on its economic arrangements. An economy is the cultural organization which develops around some central mode of economic activity. Industrialism is an economy — a cultural configuration — which has been built up around the machine technology, technics, and techniques.

Industrialism is often made synonymous with technology. The error is grave, but enlightening. All economies are technological: They function in and through a body of technics and techniques. The word "technology" refers to adjustment patterns centering about technics and techniques; "technics" implies tools, implements, instruments, and machines; "techniques" denotes skills. Technics may be mechanical, but they are also symbolic and organizational.[1] Likewise, techniques may also be mechanical, symbolic, or organizational. An economy contains all three types of technics. Tools, instruments, implements, and weapons represent mechanical technics; ideas, traditions, philosophies, and sciences are examples of symbolic technics; groups and institutions are manifestations of organizational technics. The employment of the three kinds of technics develops three types of skills: mechanical, symbolic, and organizational techniques. Technology, therefore, is an enveloping and broadly inclusive term. Industrial technology is a phrase descriptive of man's tool-using techniques at the level of machine technics.

[1] The concepts here are those suggested in L. L. Bernard, *An Introduction to Sociology, A Naturalistic Account of Man's Adjustment to His World* (New York: Thomas Y. Crowell Company, 1942), Chapter XXIX.

There is, of course, a sense in which it is proper to speak of the culture of Western civilization as technological. In no other society have mechanical technics been so thoroughly exploited as in our own. The machine, to use our popular expression, is the center of industrial culture and exercises an imperious control over all sectors of the system. What, then, is the nature of industrial machine technology?

Industrial technology centers around the use of the machine in the production and transportation of goods and services. The essence of the machine is not the instrument itself but the method of transforming random energy into disciplined energy and the means for extending man's power and sense perception. The method is the ruling idea. It involves the development of routines so that typical activities can be done by machines, thus achieving greater accuracy, dependability, and rapidity.

Industrial technology, then, is a matter of technical and social strategy. Technically, there must be some mechanism for performing a useful task. This mechanism is characteristically an engine and an end-tool. For industrial purposes, the job must be routinized and specialized, and the necessary operations must be arranged in orderly series. Any job which is repetitive can be mechanized and serialized. In this manner the productive organization establishes the means for regularity in the flow of production. Socially, there must be an organization of human relations in which human energy in a plant (adapted to a single task but related functionally to all other tasks) is accommodated to the demands of the physical equipment.

Harold M. Lambert

The machine is the center of industrial culture and exercises an imperious control over all sectors of the system.

Industrialism may be said to possess an inner structure. The purpose of industrial machine technology is to increase productivity. The basis of the system is continuity of production. Automaticity through disciplined power is the method of achieving industrialism. As Cole[2] has

[2] G. D. H. Cole, "Industrialism," *Encyclopaedia of the Social Sciences* (New York: The Macmillan Company, 1930), VIII, p. 19.

said, "Industrialism is fundamentally an affair of productive technique." Whatever its political-economic form, the spirit of industrial enterprise is "the discovery and exploitation of improved methods of producing wealth." Employed most extensively in the processes of manufacturing, industrial technology is finding a widening use in extractive and transporting activities. It has enabled public and private enterprise to cut costs by increasing the scale of operations.

The outer structure of industrial society has been built up around the technical achievements of mechanized production. Consisting chiefly of the factory system and the business firm, this outer structure has congregated workers in factories, business houses, and cities and has revised the scope and methods of business life. It has changed the personnel and status of the human labor force, has transformed the system of property-holding, and has subjected all human relations to the dictates of a global market economy.

Three features, then, characterize the industrial culture. Industrialism is a technic involving the use of machines in production. We next recognize an internal core of industrial technology. This core consists jointly of specialized machines and tools, knowledge of processes and exchange problems, and a group of human beings disciplined for industrial work. Finally, there is an outer pattern of relationships requiring a minimal concentration of men and machines in a type of group production centering around the factory. A co-operative organization of the physical and social productive factors is needed to process resources and market products. This entails a community organization which requires living quarters and which demands behavior patterns and controls for the human beings responsible for business and industrial functions (urbanism).

Harold M. Lambert

The workman's property in his craft or skill disappeared with the corporation . . .

Ewing Galloway, N. Y.

The industrial revolution was a revolution in human relations very much more than it was a revolution in production methods. It has changed the status of the human labor force.

The Inner Structure of Industrialism

Industrial civilization, although based on machines, is infinitely more than mechanized equipment. For if industrialism means the entire organization of mass production, utilizing machine technics, then the industrial revolution was a revolution in human relations very much more than it was a revolution in production methods. From it emerged the factory system, the business firm, the urban community, and new ideas associated with democracy, humanitarianism, and nationalism. The new system of human relations which it produced, not the revolutionary productive technics, marks the real significance of industrialism.

This new system of human relations, ushered in with the technical revolution, had its social origins in post-medieval Europe. The end-tool set in motion by the industrial revolution was the technological mastery induced by a new scientific outlook. In a significant sense, industrial civilization is the product of the scientific mentality. Of all human economies, industrialism alone is the product of curiosity and a systematic investigation of the human environment. In industrial society techniques or skills, once used for the fortuitous fashioning of implements and weapons, have been put at the disposal of a higher order of human behavior — that of science and philosophy — for the purpose of securing and organizing tested knowledge about the world.

From this curiosity about the world has come, as Bacon long ago predicted, "the endowment of human life with new inventions and riches." Upon this wealth technology

Harold M. Lambert

. . . and the craftsman became the propertyless industrial worker in the factory.

has laid heavy levies. The focal point of interest has been in the repetitive, the machine-like. But technology has also been generous in its rewards. On the basis of a body of tested expectations, the technician fashions tools, instruments, and machines with a reassuring dependability, a gratifying accuracy, and a desired rapidity — the very essence of the machine system.

Based on the principles of science and centering around the machine as a system of controlled efficiency, industrialism has sought the conversion of physical resources into goods for human use by means of mechanical standardization and quantity production. Efficiency is the guiding norm if not, indeed, the real end.

Industrial culture assumes a high rationality. Rational behavior is that which brings maximum machine-like adaptation of means to the given end. With the expanding utilization of symbolic technics — those of physics, chemistry, mathematics, accountancy, and so on — the pattern of living becomes increasingly abstract and overwhelmingly impersonal. The actions of life become accommodated to the rhythms of a mechanized existence. Muscular power, the patterning of life by the seasons, the creative participation in the work process become less consequential. These are valued chiefly in terms of the "unhired time" (i.e., leisure, vacations, recreations) of the individual. The uniformities of behavior become best expressed in the manner of the machine, and the ideal image of the human being becomes a mechanized one.

The Outer Structure of Industrialism

The outer structure of industrialism, manifested mainly in the factory, the firm, and the city, is an historical outgrowth of its inner structure; but the relationship is not unilinear, it is interactive. At many points and in many ways the outer pattern manages to lay claim to and direct its inner form.

The factory system is a type of group production arising from the application of mechanized power to machines. It was made possible by such technical and social developments as the standardization of the units of work and the units of product, the division and subdivision of labor, the specialization of productive functions, and the arrangement of technical operations in series. Its cooperative features must not be underestimated. It necessitates such diverse activities as the separation of mental and manual productive skills; the organization of thought in planning and processing production; the measurement of energy expenditures; the maintenance of a raw material supply; the management of productive stages; the adaptation, placement, and training of the labor force. These skills are the attributes of social intelligence and social organization.

What counts most of all is a dependable organization of work habits in the individual laborer: sustained attention, correct perception, speedy reaction, alert judgment. If these responses can be made habitual or if they can be made to function as highly motivated habits, rising productivity and lowering costs are more certain. If through the selective focusing on repetitive operations and the consequent separation of means and ends, the worker suffers degradation of his skill as a craftsman, it is really a matter of no great concern. Indeed, a long view of the factory system is apt to dismiss the degradation of craftsmanship as a mere trifle because transitory, for the productive requirements of an increasingly automatic factory

Irving Galloway, N. Y.

The massive patterns of the city grind the personal relations of industrial man exceedingly fine and thin. They create a fast rippling but shallow volume of life.

system anticipate the ultimate displacement of large masses of workers.

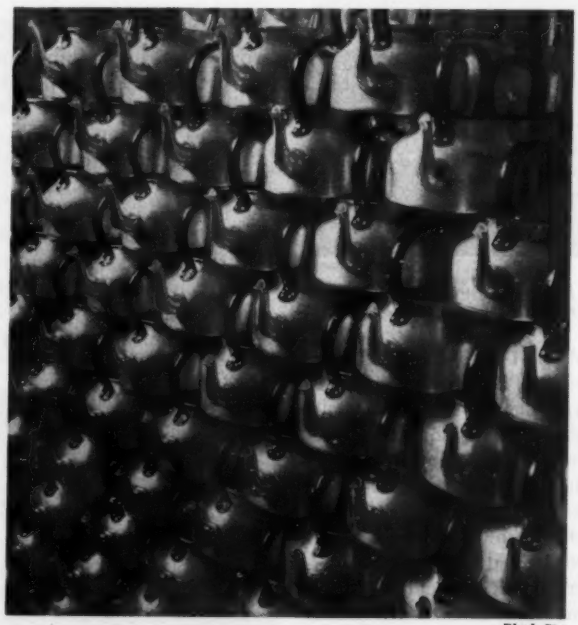
The future of the factory system is tied to that of business enterprise, and the direction which the latter is likely to take seems, at present anyway, to be unrelated to the needs or possibilities of the inner structure of industrialism. Business enterprise is a private or public system, or both; it is not inherently one or the other. In most of the industrial countries of the West both forms exist side by side. Enterprise is an organization of productive elements — a product of the co-operative work of men, land, and capital. It is a set of shared activities, and the entrepreneur may be a family, a community, a state, a person, a small group of persons, or a mass.

The factory reflects the changing fortunes of business enterprise. Several things have happened to business enterprise under the aegis of machine technics. It seems to be moving toward increasingly large-scale operations. The big firm, which concentrates operating units, workers, administrative skills, and marketing services, has come to dominate the industrial scene. There is no evidence that the large-scale enterprise has any other cause than administrative design. Except perhaps for the heavy or durable goods industries, machine technology makes no imperious demand for large-scale operations. Students of big business are much more impressed with the business methods which have fostered large-scale production than with the technical processes which might make it seem justifiable.

The principal reasons for the emergence of large business are to be found in the rise of the private corporation as a type of enterprise. Originally a public agency for the government of an area or a trade, the corporation became a business device for the conduct of business affairs, especially for those requiring large amounts of capital. Indeed, in terms of the need for investment, the private corporation has proved to be the most effective technic ever invented (outside of public finance) for the aggregation of wealth. Its rise has meant a real revolution in enterprise, particularly with respect to property. Thus the workman's property in his craft or skill disappeared with the corporation. The craftsman became the propertyless industrial worker. On the other hand, the condition of the capital owner was rendered less enviable, for the private corporation, through its separation of control from ownership, effected a radical shift in the property status of the capital lender.

The traditional logic of control over the uses of property by its owner was made impossible by multiple ownership, dispersed geographically and numerically. The stockholder became an absentee owner, and his control of property was delegated to another group of persons, the management, who stand only in a loosely regulated fiduciary relationship to him. With the corporate severance of control and ownership both the unity of property and the motivations of ownership have gone with the wind. The field of ownership was thus opened wide to legalized sabotage of production, for the line of cleavage between technician and administrator became a vast chasm.

The corporate trend in enterprise, marked as we have seen by the rise of management to power, suggests another salient characteristic of the industrial enterprise system — its administrative aspect. The business relations of enterprises with one another now take place through the medium of "administrative co-ordination." The devices are readily recognizable: administrative price-fixing, administrative rather than free competition of industrial units, marketing agreements, subsidies, and so on. The automatic adjustments of the system no longer exist, if indeed they ever did. Freely formed and free-acting markets are fast giving way to an economy of administered co-ordination, which continues on its way to fulfillment at the hands of corporate industrialism.

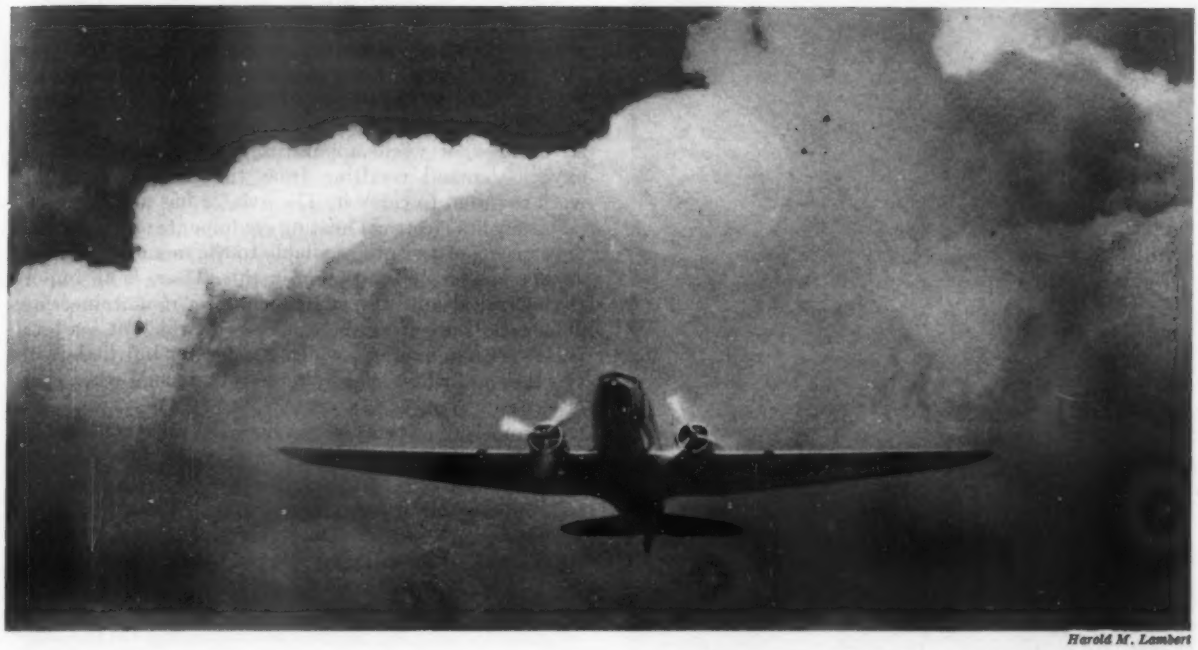


Black Star

Industrialism has sought the conversion of physical resources into goods for human consumption by means of mechanical standardization and quantity production.

The third of the subsystems which compose the outer structure of industrialism, the urban system, represents another area of the general process of industrialization. The factory served to adapt human relations to machine technics. The business firm brought a further adaptation to the organization of industrial production, and the industrial city functions to provide the community setting for industrialism. The industrial city is a new turn in the evolution of the urban system. Urban life is an old pattern. In the industrial city, machine technology sits in the center of its specialties. Probably no culture has so self-consciously employed urban life for its own ends as has industrialism. The city is the scene of its man-power mobilization. Here are the markets of business enterprise: finished products, building materials, credit, and labor. With all the talent of modern advertising and publicity, the city holds up the behavior models so valuable for advance in the industrial and business arts. Urban dominance of the culture has become an all-pervading and inescapable influence, mediated by radio and the advertising page, and glamorized by the motion pictures.

Urbanization is the indispensable partner of industrialization, the measure of its growth, the mirror of its complexities, the interpreter of its values, and the matrix of its expansion. Its concentration of buildings, of change, and of people expresses a centripetal flow of people toward the factory centers of industrial technology. The flow is held in check by great dams of (*Concluded on page 312*)



Harold M. Lambert

Zenith or Nadir?

Man's Knowledge of the Planet He Inhabits Is Restricted by the Difficulties of Overcoming Physical Limitations Binding Him to the Earth's Crust

By Frederic W. Nordsiek

IN all of limitless space, man's tiny earth is a sphere but 8,000 miles in diameter; and yet of his putative domain, man actually knows only a thin external shell. Let us first disregard the portions of the earth which have been studied by penetration with tools and instruments and measure the extent of man's insinuation of his own physical presence.

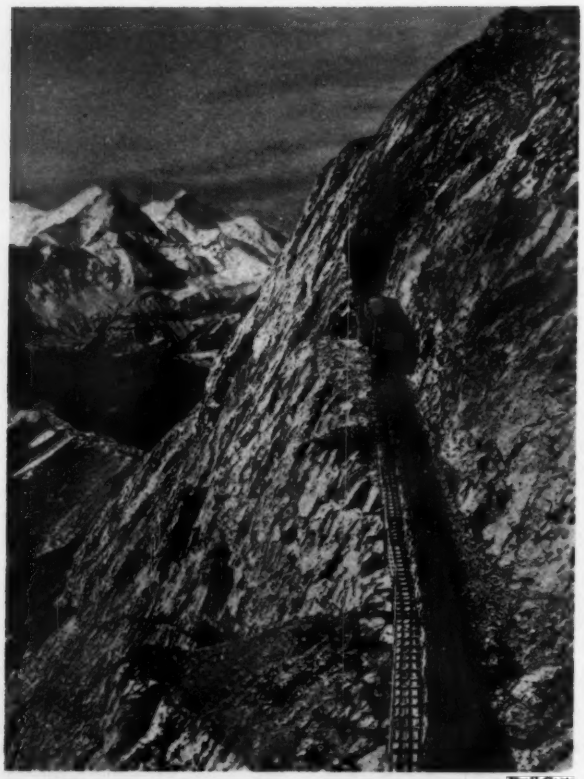
Looking upward, eminences of the earth's terrestrial surface may be ignored because the loftiest of these, though yet unscaled, dwindles to insignificance beside flights of aircraft into the stratosphere. Such an ascent by balloon, long before the day of heavier-than-air craft, in the year 1862 attained a height of 36,960 feet above mean sea level, well beyond the limit of the troposphere and a good mile higher than the tallest of mountains. In 1935 Anderson and Stevens set the record for high-altitude flight, soaring in a balloon to 72,395 feet. Thus was added to man's ken a total of 14 miles above the level of the sea.

Turning our consideration now netherward, we find that the deepest descent into the aquasphere has been a paltry 3,000 feet; this was the extent of William Beebe's bathysphere explorations in 1934. It is in the lithosphere, or solid crust of the earth, that there has been the nearest approach by man toward the core of the earth, an African gold mine which has attained a depth of 8,500 feet.

Thus of the terrestrial sphere's 4,000-mile radius, man has touched but a tiny outer mile and a half; to this he has added a more substantial, but still small, extension of 14 miles into the surrounding atmosphere.

There are good reasons why exploration, so far advanced on the surface of the earth, has been sharply limited in directions at right angles to this surface. Although the explorer meets obstacles and discomforts in tropic jungle and arctic ice field, these are slight hindrances compared to what faces him who seeks to rise far above or delve far below the level of the sea, whether in the sea itself or in the lithosphere or the atmosphere.

The sea level may be taken as optimal for human life. Here the atmospheric pressure is 14.7 pounds per square inch, the oxygen content of the air approximates a good half pound per cubic yard, and the annual mean temperature in this country at the 40th parallel is 53 degrees F., all conditions conducive to human comfort and supporting vigorous physical activity. Rising above sea level, the air rapidly becomes attenuated, until at 10,000 feet the free oxygen, a fundamental requirement of the human as of most forms of life, is almost halved, and the pressure is reduced to 10.1 pounds per square inch. Finally, the annual mean temperature, for the latitude and location given above, at this elevation drops to 30 degrees.



Emil Goetz

Looking upward, eminences of the earth's terrestrial surface may be ignored because the loftiest of these, though yet unscaled, dwindles into insignificance beside flights of aircraft into the stratosphere.

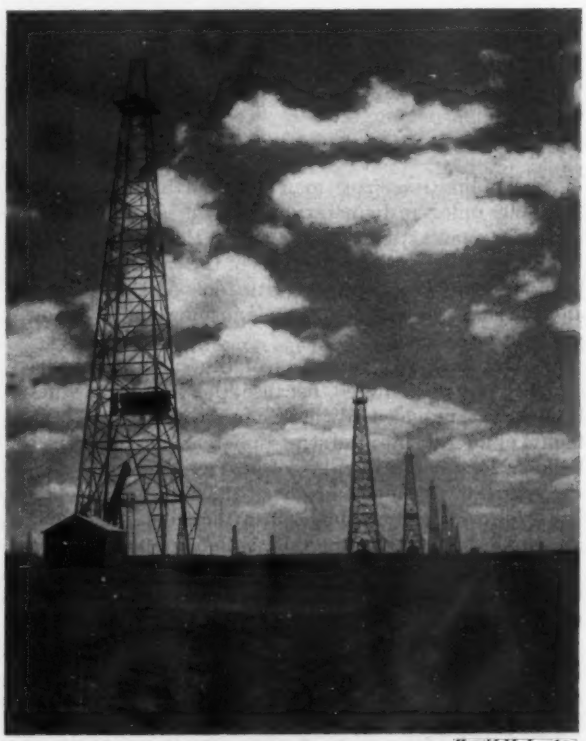
The adverse symptoms suffered by human beings at high altitudes are largely resultant from anoxemia, or oxygen deprivation of the blood and hence of all the tissues. This is true even though as soon as a man enters regions of lowered oxygen tension, certain of the truly marvelous compensatory mechanisms of the mammalian body begin to operate. Respiration automatically becomes deeper and more frequent, passing a larger volume of the dilute air through the lungs. The heartbeat quickens to speed blood circulation to the tissues. Finally, the red corpuscles, actual oxygen-transporting principle of the blood, increase in number and acquire a greater affinity for oxygen, so that the ventilating capacity of a given volume of blood is markedly augmented. Unfortunately, these expedited heart and lung functions in one respect initiate a vicious cycle. Both are forms of muscular exertion, requiring increased oxygen supply for the muscles involved.

The mountain climber and even the individual ascending a height in a funicular car or other conveyance undergo relatively gradual diminution in oxygen supply. Nevertheless, at altitudes much above 10,000 feet, symptoms of "mountain sickness" quickly develop; these are lassitude, headache, eye and ear disturbances, heart pain and palpitation, blueness of the extremities, and nausea. The person remaining at such heights for a few days achieves a degree of acclimatization, but even then he finds the slightest physical or mental exertion profoundly exhausting, since most of the available oxygen supply is demanded for the basal metabolism of the body.

The aviator, who attains great heights relatively quickly, is apt to experience no symptoms of anoxemia until he suddenly loses consciousness. Hence the flyer planning a high-altitude ascent is required to don his oxygen mask at the outset. He readily avails himself of oxygen equipment, whereas the climber must weigh the advantages of such apparatus against the increased oxygen demand resulting from the arduous muscular work required to carry it. The aviator has another great advantage in electrical heating equipment; exercise is the only means of warmth available to the mountaineer, and anoxemia sharply limits him in this. There is an important physical aptitude which occurs in mountaineering. This is evident mainly in a pulse beat which at sea level is slower than average, which accelerates but little with exercise, and which rapidly returns to normal when exercise ceases.

Diminished air pressures at high altitudes have no significance per se, but changes in pressure in the course of climbs may cause discomfort in the middle ear through expansion of the air more or less confined within this space. These changes are equalized through the Eustachian tubes, leading from the middle ear to the mouth cavity. Normal persons find little difficulty in making the necessary adjustments, particularly when the tubes are opened, by going through the motions of swallowing. On the other hand, those with congenitally narrow tubes, or with these passages clogged by catarrh or other irritations, may find middle ear distress during changes in altitude quite disabling.

The aviator rarely and the mountaineer never are subject to "bends," the deadly effervescence of the body fluids which is the scourge of the diver and is discussed



Harold M. Lambert

Oil wells, sunk to depths of 15,000 feet, permit sampling of rock and study of temperature phenomena at various depths.

below. This is because the pressure changes which the seekers after zenith experience are relatively small, even though they may be undergone quickly and may represent large changes in altitude.

Why the rigorous climate at high elevations? Why, for instance, does Mount Washington, 6,288 feet above temperate New Hampshire, have a climate equivalent to that of northern Labrador? Rising air expands because of diminishing atmospheric pressure, in turn due to the shortening column of air at successively higher levels; expanding gases cool. Thus air currents sweeping up the side of a mountain cool appreciably before reaching the peak; going down the opposite slope they warm correspondingly. Physiographers call this adiabatic cooling and heating. Furthermore, because the insulating power of air is a function of its density, the rarefied air on mountain heights prevents little of the sun's heat from reaching the ground, but conversely, loss of heat from the earth by radiation is rapid after sunset. Hence the extremes of temperature at high altitudes and the sun-suited maidens skiing at high noon on the mountain snow field. Finally, since land elevations to an extent govern air movements, winds at high altitudes are apt to be violent, particularly above timber line, where there are no trees to serve as windbreaks.

Because of the intense cold at high altitudes, more snow falls each winter than melts during the other seasons. This snow, melted by the pressure of its own weight and then refrozen into solid ice, becomes the glaciers or ice rivers which are salient features of the great mountain ranges. Consequently, in addition to the other adverse conditions enumerated above, the mountaineer risks special hazards of snow avalanches, falling rock and ice, deep ice crevasses, and difficult footing because of the bleak, rough mountain terrain. Physically he suffers all of the difficulties of the polar explorer, including snow blindness, plus special risks such as high-altitude throat, a painful condition resulting from the low temperature and extreme dryness of mountain air.

The scaling of mountain peaks has been undertaken both by sportsmen and by scientists wishing to study the phenomena of high altitudes. The Alps in Europe, Mount Aconcagua in South America, and mighty Kilimanjaro in Africa all have been conquered. As early as 1913 Stuck and Karstens scaled the highest peak in North America, 20,300-foot Mount McKinley. But the top of the world's highest mountain, 29,000-foot Everest on the continent of Asia, has never been reached. In the 1920's several carefully planned attempts were made, using the best methods and devices of the mountain climbing art. Oxygen equipment was employed, and native guides from a tribe accustomed to high altitudes were enlisted to carry the heavy apparatus. The highest level attained, nevertheless, was a good thousand feet short of the summit. Although every possible precaution had been taken, 13 human lives were lost in these attempts to scale forbidding Everest.

Such are the obstacles to exploration upward. What now hinders investigation downward?

When man burrows into the earth, he shuts off the friendly, vital sun; he must overcome engineering problems to prevent the ground from falling in and crushing him; if he is anything of a claustrophobe, there are psychological barriers to surmount. But these deterrents are readily mastered. What of the converse of difficult conditions found at great heights? Increasing air density means

Harold M. Lambert

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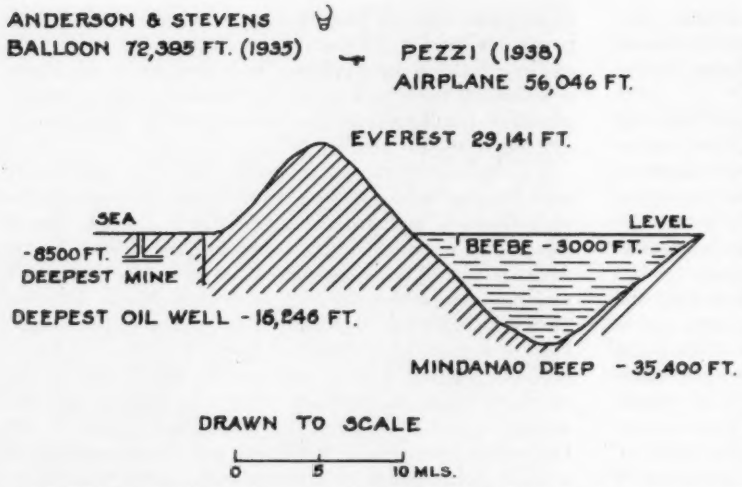


Graphical record of the heights and depths which man has reached give clear indication that his travels are still limited to within a few miles of sea level.

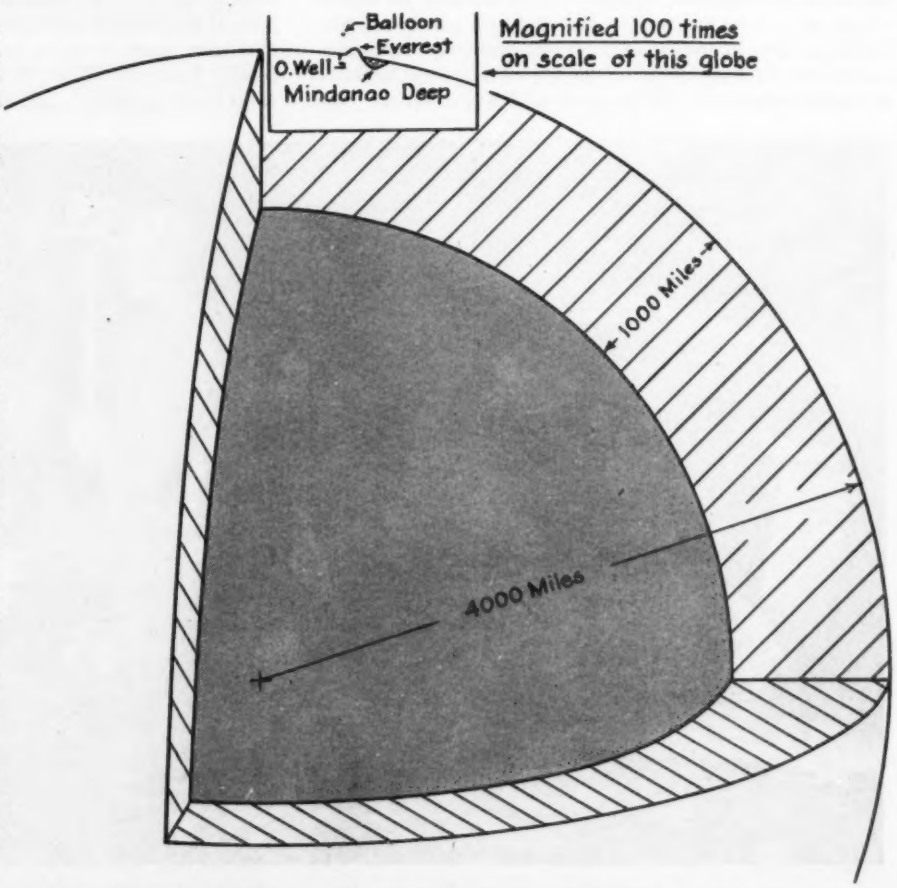
a richer supply of desirable oxygen — if anything, an advantage. The few additional pounds of atmospheric pressure existing in the deepest hole in the world appear to have no unwonted influence on the human moles who work therein. Finally, man-made abysses are cul-de-sacs; they are immune to air currents and are untouched by thermal influences of the sun. Could we not then penetrate indefinitely toward the center of the earth? How closely may mortal man approach a "burning fiery furnace"? For the core of the earth is molten; its temperature exceeds 2,000 degrees F.

Thermal gradient, or increase in temperature, at successively lower levels in the mother rock varies among different points throughout the world. For example, the Robinson Deep Gold Mine at Johannesburg, South Africa, has a Turf Shaft which is the world's deepest hole referred to above; every 220 feet of descent into the virgin rock there reveals an increase in temperature of 1 degree F.; rock temperature at 8,000 feet is 101 degrees. By contrast, virgin rock temperature at the 8,000-foot level of the deep gold mines at Saint John del Rey, Brazil, is 124 degrees. At a depth of but 7,700 feet in the Champion Reef Gold Mine, Mysore State, India, rock temperature reaches a blistering 129 degrees!

Industrial hygiene problems in the deep mines are aggravated by an adiabatic warming of ventilating air amounting to about 5½ degrees for each 1,000 feet of additional vertical depth and also by a high relative humidity; this humidity results from the necessary use of copious amounts of water in the mines to control dust in order to minimize the incidence of silicosis or tuberculosis due to inhalation of mineral dust. High humidity interferes with the natural defense of the human body against high external temperatures by diminishing the evaporation of perspiration from the skin.

Refrigeration of ventilating air has been the principal expedient for creating tolerable working conditions in the deep gold mines; at first, natural ice was used, but more recently mechanical refrigeration has been applied. However, humidity control has been vigorously advocated as more effective than temperature control, and it has been claimed that dry air could be supplied to any level by sinking separate shafts for ventilating purposes, thus preventing humidification of incoming air as it passes through the wet mine workings.

So much for the principal deter- (*Continued on page 312*)



Only a very thin shell of the earth's crust and atmosphere have been visited by man, but these puny travels have called upon all of his mental and physical achievements for their accomplishment.

The Channel Tunnel

Pipe Lines Aided the Allies by Carrying Liquid Fuel from England to the Continent; but the Fate of the Channel Tunnel Hangs in the Balance—As It Has for the Past 144 Years

By Willy Ley

IT was in April, 1942, after a demonstration of flame throwers that Geoffrey Lloyd, the British minister of petroleum warfare, asked Admiral Lord Louis Mountbatten whether there was anything else which his ministry could do to assist the coming invasion of the European continent. Lord Louis is reported to have answered with the question, "Can you lay an oil pipe line across the Channel?"

The advantages of such an idea, provided that it could be carried out, were obvious. If fuel for the Allied tanks, half-tracks, trucks, and airplanes had to be carried across the Channel by tankers (of which not too many were available), it would be vulnerable to German attack all the way. If pipe lines could be laid across the Channel, the fuel supply would be vulnerable to German attack only at both ends. Furthermore, there would be no delay, as it would not be necessary to pump the fuel into a tanker and then to pump it out again. There was no doubt about the usefulness of such an idea; the only question was whether or not it could actually be done.

The majority of British engineers questioned by Geoffrey Lloyd declared that such a project was impossible, but there were some exceptions. A. C. Hartley, the chief engineer of the Anglo-Iranian Oil Company, said that it would be possible with pipes fashioned like a submarine cable, minus its core of electric wires. B. J. Ellis of the Burma Oil Company and H. A. Hammick of the Iraq Petroleum Company had an even simpler idea. Three-inch steel pipe, they said, could be reeled up on drums and pulled off again with a reasonable degree of straightness, provided the drums were large enough, 10 yards or more in diameter.

Both types were made. The pipe suggested by Hammick and Ellis was called "Hamel," and the other, suggested by Hartley, was called "Hais" (Hartley-Anglo-Iranian-Siemens, the firm of Siemens and Henleys being the manufacturer), and since they were coining names, the whole project of Pipe Lines Under The Ocean was referred to as "Operation Pluto."

When completed, Operation Pluto consisted of four pipe lines between the Isle of Wight and Cherbourg and 16 between Dungeness and Boulogne. Of the total, 12 were Hais cable-like pipe lines and the other eight were Hamel steel pipes. Between the middle of August, 1944, and the middle of May, 1945, the Pluto pipes carried 120,000,000 gallons of fuel from Great Britain to Europe.

This system was actually only a substitute for one which the Allies might have had at their disposal had the British lawmakers of former times been a little more farsighted and known more about engineering than they did. The Allies might have had the Channel tunnel, and the Channel tunnel, had it existed, might have changed the whole pattern of the war.

The Channel tunnel is the oldest unfinished engineering project on our planet. All other projects of equal age have either been carried out a long time ago or have been definitely discarded as impractical for one reason or another. But the fate of the Channel tunnel still hangs in the balance.

The father of the idea was a French engineer by the name of Mathieu-Favier, who proposed a tunnel from Calais to Dover in 1802. He submitted his plan to the "First Consul of the Republic," namely, Napoleon, who was favorably impressed with the idea and even went so far as to propose it to Great Britain. But soon after the proposal the relations between the British Empire and Napoleon rapidly deteriorated. Napoleon harbored invasion plans, and the British built fortresses to ward off his fleet. Ironically, it was one of these old fortresses which housed one of the pumping stations for Operation Pluto.

Even if Anglo-French relations had remained friendly, the tunnel probably could not have been built then. An undersea tunnel with a total length of about 30 miles would have been a bit too much for the technology of that time; and even if the tunnel had been successfully built, engineers would have had a hard time solving the problems of illumination and ventilation a century back.

Eye for the Future

But the idea was good for future reference. It was revived after Napoleon's time by a British engineer, Dunn, whose plan actually foreshadowed Operation Pluto. Dunn wanted to save the expense of drilling such a long tunnel and proposed large iron pipes laid on the bottom of the Channel, pointing out that the highest water pressure to be encountered resulted from only 160 feet of sea water and could therefore easily be withstood by heavy large pipes. Dunn's project died in the course of time, but it, too, was good for future reference.

Before we go on, it might be useful to become acquainted with a few figures. The width of the Channel between Folkestone on the English side and Cape Gris Nez on the French side is about 20 miles. The deepest portion of the Channel along an imaginary line linking these two points is 160 feet. For safety reasons, the tunnel should be located some 100 to 120 feet below the bottom of the Channel, making the total depth below sea level around 280 feet. At that depth the safety would be absolute, but such depth would, of course, increase the length of the tunnel, since long inclines would be needed on both sides. Thus the total length of the Channel tunnel would be 30 miles, with 20 miles under the sea. An electric

train, traveling at the conservative rate of 60 miles an hour, would need just one half hour to go from entrance to exit, and with electric trains and electric illumination the ventilation problem would not present any special difficulties.

The Simplon Tunnel in the Alps, which was opened to rail traffic in 1906, is 12¼ miles long but had to be drilled through hard rock, whereas the Channel tunnel would lead all the way through gray chalk, a sedimentary rock which, being soft and easy to work, offers little resistance to modern machinery.

Some years after Dunn's plan, two French engineers advanced another proposal. Probably being afraid of ventilation trouble, they drew up plans for a high Channel bridge, 24 miles long and estimated to cost close to a billion gold dollars. Reconsidering their own proposal, the two engineers, Ransonnet and Polonçeau, later advocated a dam with a few gaps (spanned by high bridges) for ships to pass through. The dam was supposed to cost only one-fifth of the price of a continuous bridge.

It is almost needless to say that none of these early plans did more than provide newspaper and magazine writers with interesting material. But in 1856 events took a more serious turn. Napoleon III then ruled France, and when a French engineer, Thomé de Gamond, came to him with a plan for a tunnel from Folkestone to Gris Nez, the French emperor immediately favored it. Napoleon III supported De Gamond not only because the plan was good, generally speaking, but also because his uncle, Napoleon I, had supported Mathieu-Favier.

On the British side, De Gamond was not greeted with such enthusiasm. Lord Palmerston simply asked him, "How can you expect us to reduce a distance which is too short as it is?" Nautical experts vetoed the plan too. De Gamond wanted to create 14 artificial islands housing ventilating shafts along the length of the tunnel, but he was told that Channel navigation was too difficult as it was, without 14 artificial obstacles in the way of shipping.

But De Gamond did not give up. Ten years after his first attempt he presented a new plan. In 1872 a firm for the purpose of building the tunnel was founded under the name of Channel Tunnel Company, and in 1877 the three chief engineers of the firm presented the final plans to both governments involved. In 1882 actual work began.

Near Shakespeare Cliff on the English side and near Sangatte on the French side two vertical shafts more than 400 feet deep were excavated, and from their bottoms mile-long "galleries" were driven seaward. These galleries beautifully confirmed the predictions of the geologists. The rock under the bottom of the Channel was gray chalk, a solid layer several hundred feet thick, with no signs of breaks or interruptions. It was ideal material for underwater tunneling, being impervious to water and also soft enough to be worked without blasting.

Everybody had the highest hopes, and then a single arrogant and prejudiced conservative caused the end of the great plan and put an indeterminate delay on the Channel tunnel: General Wolseley, who was then chief of the British general staff, declared that a Channel tunnel would be "a permanent menace to English security" and exerted all his authority to prevent the tunnel from being built. Of course, he could not forbid it, as he would have liked, because the project had to be investigated by a parliamentary committee. The committee, consisting of members of both Houses of Parliament, deliberated for a long time and finally decided with a vote of six to four against the project but was unable to name a reason for its vote.

The Channel Tunnel Company did its best to save the case. It promised to build, on the English side, a citadel which, equipped with heavy artillery, would not only be able to ward off an enemy attack but could also shell the tunnel mouth into collapse. The company also promised heavy automatic steel doors and changed its plans to include an otherwise unnecessary four-mile "dip" in the tunnel for quick flooding. Nothing helped; General Wolseley remained adamant. Work was stopped in 1884, and the Channel Tunnel Company was dissolved a year later. Countless investors lost their money, and at an examination of the two galleries half a century later it was found that the machines were still standing on virtually dry ground.

In 1906 the Simplon Tunnel was opened, and since Lord Asquith had said two years earlier that he "was not unfriendly" to the idea of a Channel tunnel, the British Government was approached again. The premier was then Sir Henry Campbell-Bannermann, but General Wolseley was still alive, and Campbell-Bannermann said "no." In 1914, when it became apparent that war was coming, Lord Asquith was approached again. He must have been afraid of Wolseley's ghost because he, too, rejected the project.

Military Value

That the reasoning behind these rejections was not only poor but unsound from a military point of view has been stated clearly by a military man who certainly was a better general than Wolseley. Questioned after World War I about the Channel tunnel project, Marshal Foch stated roundly, "If the Channel tunnel had been built, it might have prevented the war, and in any event it would have shortened its duration by one-half."

That was in 1922. Two years later the project was revived once more, again by French interests. In the meantime, poison gas had been used militarily, and electric trains had become common. So the French offered in addition to the citadel, the floodable "dip," and the steel doors, a system whereby the tunnel could be filled with poison gas from the English side and the electric power for illumination and for propulsion of the trains could come from a power plant on the English side, using a voltage different from the French standard. On their own part, the French said, they would be satisfied with a steel door, six 75's, and 30 machine guns for the defense of the "mousehole."

The government of Ramsay MacDonald rejected the project. Winston Churchill stormed, but to no avail.

In 1928 the campaign for the Channel tunnel was renewed. When Wolseley started the fashion of condemning the Channel tunnel, he had had at least one good argument: Great Britain was an insular power, and the tunnel would end its insularity. But during World War I the Paris Gun had shot over a range of 80 miles, and German airplanes and Zeppelins had bombed London. The insularity did not exist any more, at least not in the old sense. In short, the tunnel was rejected once more.

In 1939, during the period of the so-called "phony war," the Allied Supreme War Council discussed the tunnel once more, wondering (*Concluded on page 322*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Deputy Dean

APPOINTMENT of Professor Thomas K. Sherwood, '24, as deputy dean of engineering at the Institute, effective February 1, was announced in January by President Compton. Dr. Sherwood will share with Edward L. Moreland, '07, Dean of Engineering, the academic administration of the 12 departments included in the School of Engineering and the research programs associated with these departments.

Edwin R. Gilliland, '33, who accepted appointment last July as deputy dean of engineering for a temporary period only, returns now, in accordance with his plan, as a full-time professor in the Department of Chemical Engineering.

Professor Sherwood is a native of Columbus, Ohio, and was educated at McGill University, from which he received the degree of bachelor of science in 1923, and at the Institute, where he did postgraduate work leading to the degrees of master of science in 1924 and doctor of science in 1929 in chemical engineering. He was an assistant in chemical engineering for two years beginning in 1924, and from 1928 to 1930 he was assistant professor of chemical engineering at Worcester Polytechnic Institute. In 1930 he returned to the Institute to become assistant professor of chemical engineering and was promoted to the rank of associate professor in 1934 and to professor in 1941.

Professor Thomas K. Sherwood, '24, recently appointed deputy dean of engineering at the Institute

During the war Professor Sherwood was in turn a technical aide, a section chief, and a division member of the National Defense Research Committee, with which he has been associated since 1940. In 1942 he was consultant to the Baruch Committee, and in 1944 he was appointed expert consultant to the War Department.

The American Institute of Chemical Engineers chose Professor Sherwood to receive the William H. Walker Award in 1941. Professor Sherwood is a member of Sigma Xi, Alpha Chi Sigma, the American Chemical Society, and the American Institute of Chemical Engineers. He is the author of more than 50 technical publications, including two books on chemical engineering.

John D. Mitsch, 1898–1946

JOHN D. MITSCH, '20, Associate Professor of Structural Engineering in the Department of Civil and Sanitary Engineering, lost his life in an airplane accident on January 18.

Except for the period of a year in 1924, when he gained experience in the field as an estimator and superintendent of construction on concrete buildings, Professor Mitsch had been a member of the instructing staff since his graduation in 1920. In addition to his teaching duties in the field of stress analysis and bridge and reinforced concrete design, he had been active for many years in teaching and administrative work at Camp Technology, the Institute's engineering camp in Maine. He was made an assistant professor in 1934 and was promoted to associate professor in 1940. He was a member of the American Society of Civil Engineers and the American Concrete Institute. He is survived by his wife, the former Frances McFaul of Machias, Maine, and two children, Mary R. and John D., Jr.

Annual Ballot

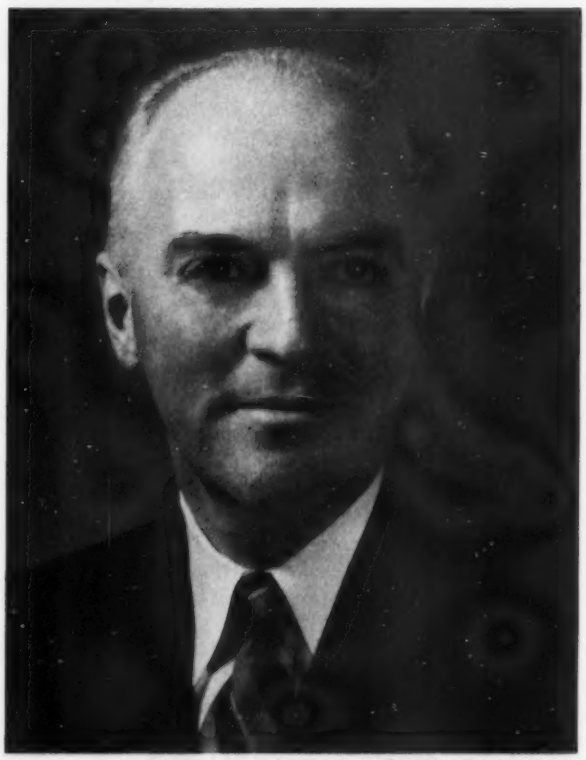
BALLOTS to be mailed this month will give members of the Alumni Association of the Institute opportunity to vote for officers and representatives of the Association and for term members of the Corporation.

The National Nominating Committee — consisting of Samuel C. Prescott, '94, chairman, Albert W. Higgins, '01, Fred W. Morrill, '07, Harry L. Havens, '09, Orville B. Denison, '11, Irving W. Wilson, '11, Frank Maguire, '17, Raymond R. Ridgway, '20, Charles A. Williams, '21, and Charles H. Toll, Jr., '23 — has proposed Alfred P. Sloan, Jr., '95, VI, chairman of the board of directors, General Motors Corporation, New York City, to serve as honorary president of the Alumni Association for the coming year. The establishment of this new post brings to the Association the leadership of a loyal Alumnus and one of the country's most outstanding industrialists.

The National Nominating Committee has named the following Alumni for office: for president, Harold Bugbee, '20, X, XV, President, Walter B. Snow and Staff, Inc., Boston; for vice-president, C. George Dandrow, '22, IX-B, Vice-president, Johns-Manville Corporation, New York City; for election to posts on the Executive Committee, Avery A. Ashdown, '24, V, Associate Professor of Organic Chemistry at the Institute, and Larcom Randall, '21, VI, associated with T. O. Metcalf Company and long identified with industrial and technical advertising.

Named for term membership on the Corporation are: A. Warren Norton, '21, XV, President, Press Wireless, Inc., New York City, and retiring President of the Alumni Association; Frederick S. Blackall, Jr., '22, XV, President and Treasurer, The Taft-Peirce Manufacturing Company, Woonsocket, R. I.; and Albert J. Browning, '22, XV, Director, Office of Domestic Commerce, Department of Commerce, Washington, D. C.

New representatives on the National Nominating Committee are to be elected this year by Districts 1, 2, 4, and 5 to succeed Messrs. Prescott, Denison, Ridgway, and Maguire. The men placed in nomination, one to be elected for each district, are: *District 1:* Robert S. Williams, '02, V, Head of the Department of Metallurgy at the Institute; Frank P. Scully, '15, I, President and Treasurer, Scully Signal Company, Cambridge; *District 2:* Robert C. Erb, '17, XV, Treasurer and general manager, J. F. McElwain Company, Nashua, N. H.; Robert G. Holt, '33, IX-B, National Life Insurance Company,



George M. Cushing, Jr.

FOR PRESIDENT ▶

. . . of the Alumni Association of the M.I.T., Harold Bugbee, '20, X, XV, has been named to serve for the coming year. Mr. Bugbee has been associated with Walter B. Snow and Staff, Inc., industrial advertising counsel, for virtually his entire business career and since 1928 has been president of that corporation. Mr. Bugbee is permanent secretary of the Class of 1920 and has been appointed a member of the executive committee of the Alumni Association to fill the unexpired term of the late John D. Mitsch, '20. He is a member of the Alumni Council, the Alumni Advisory Committee on Musical Clubs, and the Technology War Record Committee, and he was vice-president of the Alumni Association for 1941–43. As special lecturer in Course XV, Business and Engineering Administration, he created and for eight years conducted a course in industrial advertising for graduate students and seniors at the Institute. For two terms he served as chairman of the board of governors of the New England section of the American Association of Advertising Agencies and on the national executive board of that association. Mr. Bugbee is a member of the National Industrial Advertisers Association, the Boston Advertising Club, the Winchester Country Club, and the Winchester Boat Club. His home is in Winchester, Mass.

◀ FOR HONORARY PRESIDENT

. . . of the Alumni Association of the M.I.T., Alfred P. Sloan, Jr., '95, VI, is nominated. After graduation from the Institute, Mr. Sloan was associated with the Hyatt Roller Bearing Company and from 1897 to 1916 was president of this firm. From 1916 to 1918 he was president of the United Motors Corporation. His administrative activities with the General Motors Corporation began in 1918 and he served as vice-president until 1923. From 1923 to 1937 he was president of this corporation and since 1937 has been chairman of the board of directors. Mr. Sloan is a member of the board of directors of E. I. du Pont de Nemours and Company, Pullman Company, Ethyl Corporation, J. P. Morgan and Company, Kennicott Copper Corporation, Braden Copper Company, and Pullman Incorporated. He is a trustee of the Memorial Hospital in New York and of the Sloan-Kettering Institute for Cancer Research. Mr. Sloan is a member of the Society of Automotive Engineers, Delta Upsilon fraternity, the National Republican Club, the Detroit Club, the University, Metropolitan, and New York Yacht clubs in New York, the Turf and Field Club in Belmont Park, Long Island, the Bath and Tennis Club in Palm Beach, Fla., and the Piping Rock Club in Locust Valley, Long Island. He is president of the Class of 1895 and a life member of the Corporation of the Institute.

U. S. Signal Corps Photo © Bachrach Underwood and Underwood

TO THE CORPORATION

. . . for five-year term membership representing the Alumni Association, the National Nominating Committee has named these three Alumni. From left to right they are: Albert J. Browning, '22, Director, Office of Domestic Commerce, Department of Commerce, Washington, D. C.; A. Warren Norton, '21, President, Press Wireless, Inc., New York City, and retiring President of the Alumni Association; and Frederick S. Blackall, Jr., '22, President and Treasurer, The Taft-Peirce Manufacturing Company, Woonsocket, R. I.

Montpelier, Vt.; Henri Gaudefroy, '34, VI, Ecole Polytechnique de Montreal, Montreal, Canada; *District 4:* Ralph C. Robinson, '01, V, General Electric Company, Schenectady, N. Y., retired; Harold F. Hedberg, '20, II, assistant superintendent, Albany Felt Company, Albany, N. Y.; Whitworth Ferguson, '22, VI, President and Treasurer, Ferguson Electric Construction Company, Buffalo, N. Y.; *District 5:* Gordon G. Holbrook, '10, XIII, works manager, Federal Shipbuilding and Dry Dock Company, Kearny, N. J.; William H. Mueser, '22, I, Moran, Proctor, Freeman, and Mueser, New York City.

Research Laboratory of Electronics

ELECTRONIC devices and the principles of electronics find application on every hand. There is no departmentalization of the particles of matter, and basic research cuts across many branches of science. It is natural, therefore, that the recently organized Research Laboratory of Electronics at the Institute should provide graduate training and research facilities as an interdepartmental enterprise under the joint sponsorship of the Departments of Electrical Engineering and Physics.

The objectives of the new laboratory are to increase the unity and effectiveness of technical education offered at the Institute; to offer better facilities for conducting study to students engaged in research in several fields touched by electronics; and to provide adequate facilities to carry on effective research and the opportunity to work on the frontiers of knowledge in electronics. To fulfill its objectives the laboratory will be primarily concerned with basic research rather than with problems which might be classified as developmental engineering.

It is intended that the activities of the laboratory shall cover broadly the field of electronics, although the heritage of the war makes it inevitable that emphasis will fall heavily on certain unfinished phases of war research. In fact, a number of activities of Division 14 of the National Defense Research Committee which were in an uncompleted stage at the Radiation Laboratory at the end of the year will be taken over by the new Research Laboratory of Electronics.

The program outlined for the laboratory is broad in scope and makes provision for research on such topics as:

(1) Microwave electronics, in which emphasis is to be placed on the basic sources of microwave electromagnetic power and apparatus and techniques for dealing with electromagnetic radiation in the region of the spectrum between infrared and the shortest waves used in radio communication.

(2) Basic physics, involving the study of the electromagnetic properties of matter at microwave frequencies.

(3) Electronic techniques applied to the problems of physics and engineering. Included in this classification are the development of instruments and techniques for measuring very high-speed electrical phenomena, research on the generation of sound waves at frequencies above 30,000,000 cycles a second, and development of components for the acceleration of charged particles to extremely high energies.

(4) Microwave communication, dealing with the basic problems governing the transmission and reception of information, and engineering applications for the development of advanced communication systems. Wide band transmission, pulse techniques, and studies of interference are topics for research which fall logically under this program.

(5) Electronic aids to computation to be studied in a program closely co-ordinated with the Institute's plans for the support of applied mathematics.

A notably large number of the Institute's staff have a direct interest in electronic research or an indirect interest derived from its relation to other projects. Many of these men have formulated research problems and by virtue of their knowledge and leadership have drawn to themselves a following of students. The Research Laboratory of Electronics is conceived as a federation of these groups with a common interest in electronics. By the pooling of

effort, facilities and support can be made available on a large scale not possible to isolated units. By building on the principle of federated activity, the laboratory hopes to gain the advantage of co-ordination without restricting freedom of effort on the part of any individual profession or group.

The Institute is fortunate in having on its staff a large number of men whose interests and experience lie all or partly in the field of electronics. Among them are men who have made important contributions to our knowledge of electromagnetic theory, microwave electronics, mathematical analysis, atomic power, and acoustics.

The laboratory will be under the direction of an executive committee composed of Professor Julius A. Stratton, '23, of the Department of Physics, director; Professor Harold L. Hazen, '24, Head of the Department of Electrical Engineering; Albert G. Hill, Associate Professor in the Department of Physics, associate director; and Professor John C. Slater, Head of the Department of Physics.

Reports and Progress

ONE hundred and twenty-two members and guests attended the 248th dinner meeting of the Alumni Council which was held in Pritchett Hall, Walker Memorial, on January 28. In calling the meeting to order, President A. Warren Norton, '21, paid tribute to the late John D. Mitsch, '20, Associate Professor of Structural Engineering and a member of the executive committee, whose tragic death occurred in an airplane accident on January 18.

The report of the National Nominating Committee, presented on pages 295–297, was read, and the following committee members for Alumni Day, February 23, were proposed and elected by the Council: *General Chairman:* Larcom Randall, '21; *Class Day:* John A. Hrones, '34, chairman, Eugene Mirabelli, '19, George A. Wilson, Jr., 10–44; *Dinner:* Frank R. Shaw, '24, chairman, Donald G. Morse, '21, Parke D. Appel, '22, A. Robert Tonon, '22, David S. McLellan, '37; *Ladies:* Mrs. Leicester F. Hamilton; *Publicity:* Ralph T. Jope, '28, chairman, Henry B. Kane, '24, James Donovan, '28, Beverly Dudley, '35, John J. Rowlands, staff; *Registration:* Donald P. Severance, '38, chairman, Joseph C. MacKinnon, '13, Robert M. Kimball, '33, Wolcott A. Hokanson, staff; *Ways and Means:* Horace S. Ford, staff, chairman, Carl M. F. Peterson, '29, Delbert L. Rhind, staff.

Plans for Alumni Day of February 23 were progressing well, Mr. Randall stated. For the Alumni Day to be held early in June, William L. Campbell, '15, was elected to serve as chairman.

Announcement was made that Harold Bugbee, '20, had been elected by the executive committee to serve as a member of that body to fill the unexpired term of the late Professor Mitsch. A special committee on 25-year anniversary consisting of Alexander D. Harvey, '21, William H. Mueser, '22, Horatio L. Bond, '23, George E. Parker, '24, and John C. Dunbar, '25, was also elected.

Henry B. Kane, '24, Director of the Alumni Fund, announced that in the current year, with two months still to go, Alumni had contributed $150,400 to the Fund, already exceeding by $400 last year's peak.

President Compton then touched upon highlights of the latest developments in the Institute's administration. For graduation exercises on February 25, Lieutenant General J. H. Doolittle, '24, was chosen to give the commencement address. A grant of Alfred P. Sloan, Jr., '95, has made possible the purchase of a new building for the Department of Aeronautical Engineering, and an anonymous gift of half a million dollars for research was also announced by Dr. Compton. The large volume of applications for admission is creating conversion difficulties, particularly since an unusual peak is anticipated for the next few years to provide training to returning veterans. Available facilities are taxed to accommodate as many students as feasible, consistent with the Institute's high educational standards. To aid in alleviating the housing shortage for students living in Cambridge, a new dormitory is planned for erection on Memorial Drive, west of Massachusetts Avenue.

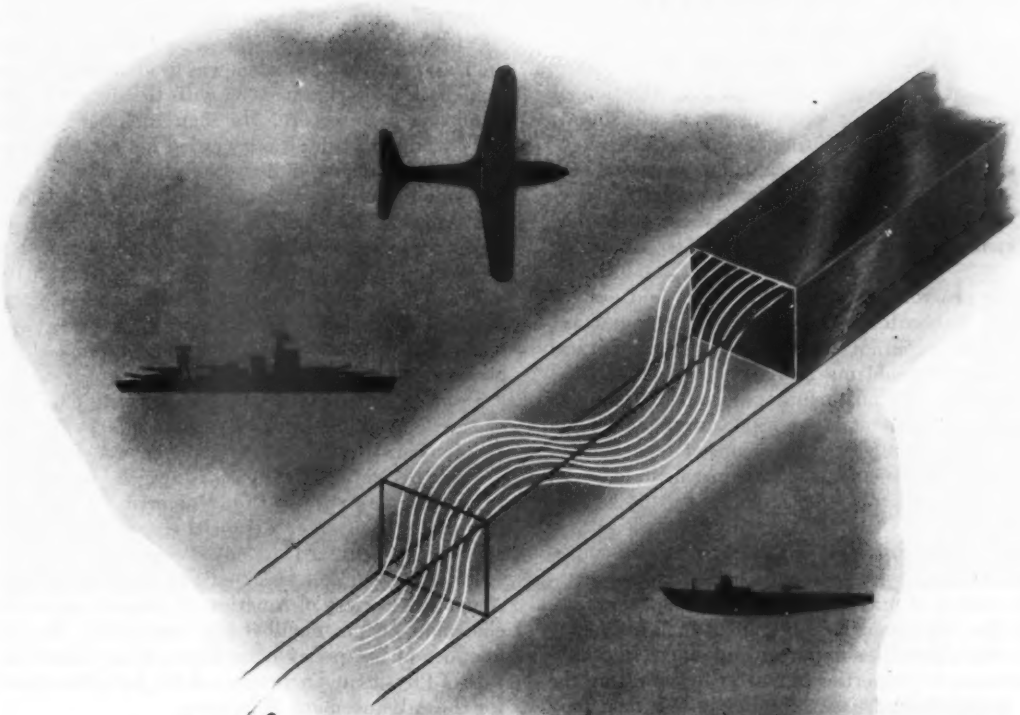
Final speaker of the evening was George R. Harrison, Dean of Science, who recounted interesting aspects of a trip he made during the war to arrange with General MacArthur for a group of scientists to carry on war research projects in Australia. Uneventful for the most part, the trip across the Pacific provided its excitement when trouble developed in the plane's gas lines, and radar was used to locate a landing field on a small mid-Pacific island. In Australia travel was exasperating because railroad tracks of different gauge were often encountered necessitating transfer from one train to another every few hundred miles. Yet this annoyance could be overcome by standardization and agreement of railroad operators. Finally, Dean Harrison, speaking on the atomic bomb, gave a dissertation on atomic energy. In emphasizing the energy derivable from different materials, Dean Harrison compared the energy obtainable from a fragment of uranium ore with that obtainable from such materials as a stick of dynamite, a pat of butter, and a lump of coal.

Acoustics Research

ESTABLISHMENT at the Institute of an Acoustics Laboratory, a new interdepartmental facility in a branch of science which produced important developments during the war, was recently announced by Dr. Compton. One of the primary objectives of the new laboratory is to provide fundamental professional training in a field in which there is now a serious shortage of competent engineers and scientists.

The new laboratory is to be operated under the joint direction of the Departments of Physics and Electrical Engineering and the School of Architecture and Planning and will collaborate with all departments interested in acoustic problems. Richard H. Bolt, Assistant Professor of Physics, has been appointed director of the new laboratory, which will be supervised by a committee consisting of Professor Philip M. Morse, of the Department of Physics, chairman of the committee; Richard D. Fay, '17, Associate Professor in the Department of Electrical Engineering; Professor Julius A. Stratton, '23, director of the Research Laboratory of Electronics; and Professor Lawrence B. Anderson, '30, of the School of Architecture and Planning.

Present facilities at the Institute for research in acoustics include a microphone calibration system installed in an especially sound-deadened room; a sound- and vibration-isolated room adapted for reverberation and other acoustics studies; special (*Continued on page 300*)



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This achievement of America's oldest metal-working [illegible] shows that, as a result of its 144 years of experience it has acquired the priceless habit of questioning the obvious, of creating new answers to new problems. Yet valuable as such Revere service can be, it is surpassed by the day-to-day help Revere offers industry in the use of Revere's standard products. We have merged the science of the metallurgist with the skill of the artisan to help with your routine problems. Both the Revere Technical Advisory Service and all Revere metals are ready to serve you *now*. Listen to *Exploring the Unknown* on the Mutual Network every Sunday evening, 9 to 9:30 p.m. E.S.T.

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230 Park Avenue, New York 17, N. Y.

THE INSTITUTE GAZETTE

(*Continued from page 298*)

equipment and experimental rooms for investigation of audible sounds; devices for studying ultrasonic sound; and acoustic impedance measuring equipment.

Special apparatus has been constructed for the new laboratory to measure ultrasonic absorption and reflection of materials under water. It was in these fields that notable advances were made in war research on submarine warfare.

A five-year program of research has been laid out for the Acoustics Laboratory. One of the most important divisions of this program will deal with architectural acoustics, and the problems to be studied include the physical properties of acoustic materials and structures as well as functional acoustic design. Special provisions will be made for such investigations by means of experimental full-scale rooms. Studies of special interest include sound absorption, distribution, and transmission in various types of structures.

The program also provides for studies in electro-acoustic instrumentation, which includes investigations concerning the design of microphones and loud-speakers.

Still another significant field is that of high-frequency vibrations which promises important advances in studying the microscopic properties of matter by vibrating the molecules in liquids and gases. Studies in this field may lead to the development of acoustical microscopy. This part of the program will be carried on in collaboration with the Institute's Research Laboratory of Electronics.

Dr. Bolt, director of the laboratory, who is the son of Dr. Richard A. Bolt of the school of public health at the University of California, was graduated from the University of California in 1933 with the degree of bachelor of arts in architecture. He then took up the study of physics, in which he was awarded his master's degree in 1937 and the degree of doctor of philosophy in 1939, having done thesis research at the University of California at Los Angeles. He carried on special advanced work in Germany in 1933 and 1934 and was a National Research Fellow in physics at the Institute from 1939 to 1940.

From 1940 to 1943 Dr. Bolt was an associate in physics at the University of Illinois and an assistant professor from 1943 to 1944. Last year he was appointed assistant professor of physics at the Institute.

From 1943 to 1944 Dr. Bolt was scientific liaison officer of the Office of Scientific Research and Development in London, and from 1944 to 1946 he was chief technical aide of the National Defense Research Committee.

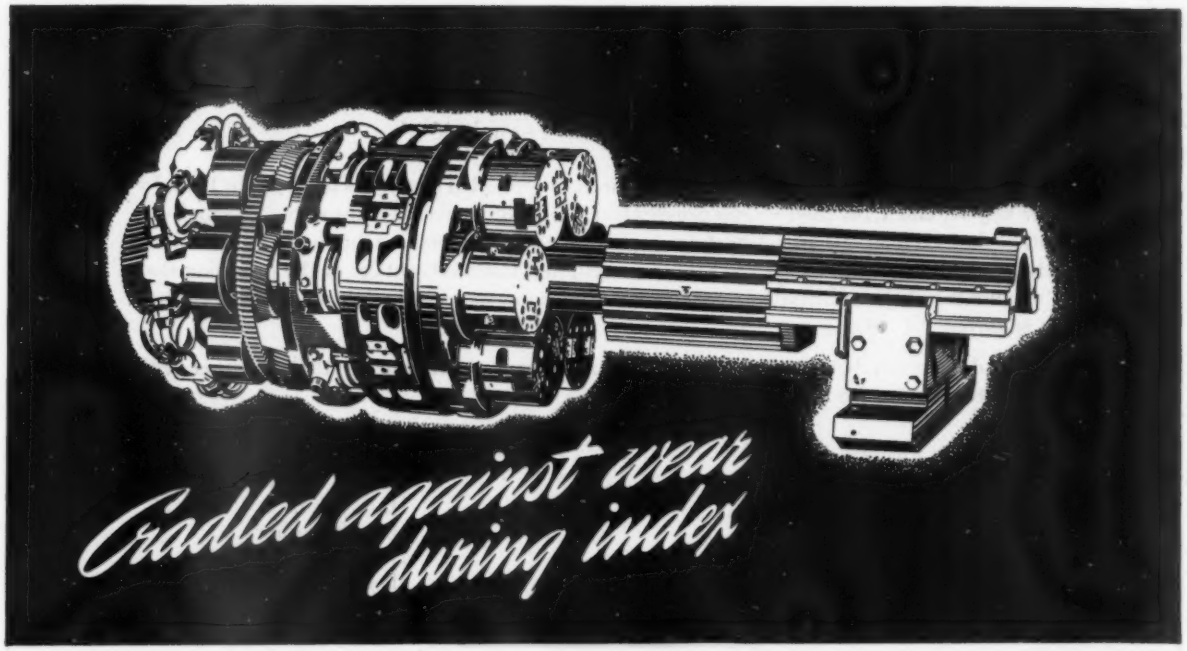
His academic career at the University of California won for him the Houghton Memorial Key in 1939. He was also elected to Phi Beta Kappa and Sigma Xi.

In 1942 Dr. Bolt received the biennial award of the Acoustical Society of America, of which he is a fellow and chairman of the membership committee. He is also a member of the policy committee of the American Institute of Physics and a member of the American Association for the Advancement of Science.

(*Continued on page 304*)

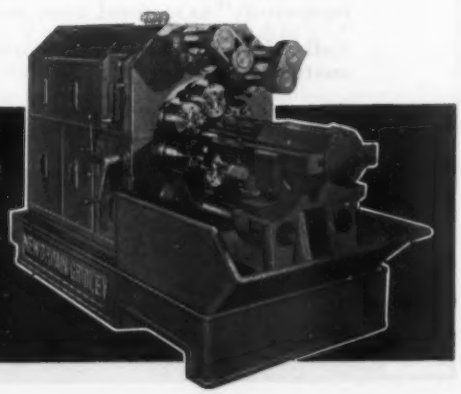
DOUBLE HONORS

. . . came to Major General Roger B. Colton, '20, on January 8, when General H. H. Arnold made presentation of the Legion of Merit and the Distinguished Service Medal. The citation for the Legion of Merit reads: "Major General Roger B. Colton performed outstanding services from August, 1941, to June, 1943, as chief of the matériel branch and later director of the supply service, Office of the Chief Signal Officer. In charge of supplying communication equipment, including radar, to the Army and to many of the United Nations, he supervised all phases of supply from the earliest stages of research through delivery. He discharged these responsibilities with extraordinary executive skill and with singular comprehension of the diverse technical and industrial fields which his work encompassed. These talents, coupled with his great vigor, initiative, and ingenuity, his foresight and sound judgment, and his admirable qualities of leadership, guided all activities under his control to record production despite critical shortages of materials. General Colton's performance of duty contributed materially to the war effort." The Distinguished Service Medal carries with it the following citation: "Major General Roger B. Colton distinguished himself from September, 1944, to September, 1945, by the exceptionally meritorious manner in which he discharged heavy responsibilities as air communications officer of the Air Technical Service Command, Wright Field, and electronics adviser to the assistant chief of Air Staff-4, Headquarters Army Air Forces. He directed the transfer from the Signal Corps to the Army Air Forces of the research, development, procurement, storage, and issue of communications items and other electronic equipment peculiar to the Air Forces. His contributions to many electronic devices, including developments which made possible increased resolution leading to the application of radar to strategic bombing, fire control, and guided missiles, were outstanding and brought about the operational use of these implements years ahead of the most optimistic estimates of the scientific world. By his keen vision, professional knowledge, perseverance, and tireless efforts, General Colton contributed notably to the successful prosecution of the war."



.....PART OF THE FRAME DURING THE CUTTING CYCLE

The spindle carrier assembly is the very heart of an automatic machine . . . key to its accuracy and dependability. On New Britain Automatics, the spindle carrier is automatically lifted out of contact with the frame of the machine during index. When index is complete it is not only re-seated but clamped to the frame, becoming in effect an integral part of it. This exclusive New Britain feature practically eliminates wear and weave during the cutting cycle . . . assuring the continued accuracy for which New Britains are famous. Other exclusive features provide unmatched speed and accuracy. The sum of them all is PRODUCTION . . . more parts per dollar.



NEW BRITAIN

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THE TECHNOLOGY LOAN FUND BOARD

Report for the Year 1945

Current principal repayments during the year again exceeded new loans made, as in 1944, by *over fivefold*, and 1,762 men — *over two-thirds* of the 2,608 receiving loans since the Fund was established in 1930 — had completely discharged their financial indebtedness by December 31, 1945. Many of the 1,762, and others as well, had taken advantage of the provision that "payments may be anticipated," for $72,830.50 of notes were paid off during 1945 *in advance of maturity*.

The data given below summarize the Fund's transactions during 1945 together with cumulative figures for the past fifteen years.

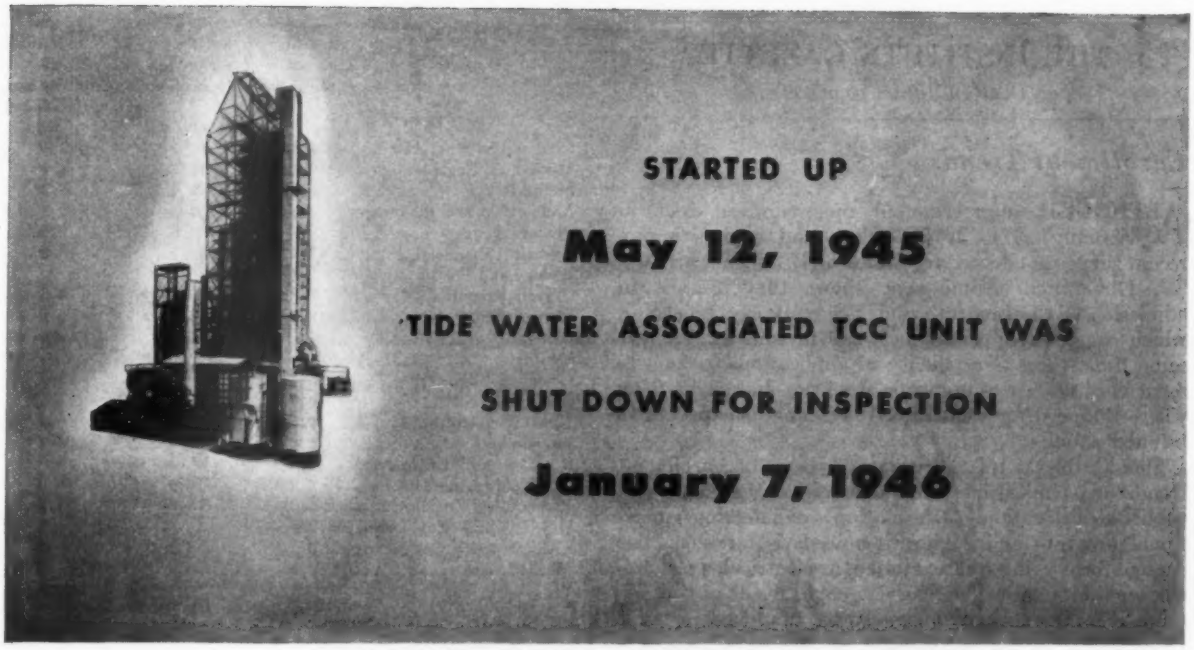
The Technology Loan Fund Board
K. T. Compton,
H. S. Ford,
B. A. Thresher,
D. L. Rhind, *Secretary*
H. E. Lobdell, *Chairman*

Cambridge
February 1, 1946

Cumulative Record of the Technology Loan Fund from its establishment in 1930 up to December 31, 1945, and the corresponding figures up to December 31, 1944, together with net changes during 1945.

Items of Outgo	*At Dec. 31 1944*	*At Dec. 31 1945*	*Net Changes during 1945*
Number of men receiving loans	2,584	2,608	+24
Total amount loaned	$1,881,865.75	$1,895,273.75	+$13,408.00
Average per capita loan	$728.27	$726.71	−$1.56
Items of Income			
Number of men whose indebtedness has been completely discharged	1,572	1,762	+190
Principal repayments *in advance*	$425,376.87	$498,207.37	+$72,830.50
Other principal repayments	$854,655.47	$924,652.50	+$69,997.03
Total principal repayments	$1,280,032.34	$1,422,859.87	+$142,827.53
Total principal matured, considering "advance repayments" as matured when paid	$1,321,421.22	$1,460,825.98	+$139,404.76
Collection Ratio, *i.e.* percentage of total maturities paid	**96.9%**	**97.4%**	**+0.5%**
Matured principal in arrears	$38,991.53	$32,762.12	−$6,229.41
Actual "written off" accounts	$2,397.35*	$5,203.99**	+$2,806.64
Total maturities unpaid	$41,388.88	$37,966.11	−$3,422.77
Interest received	$187,734.33	$199,235.78	+$11,501.45
Notes Outstanding	$599,436.06	$469,956.53	−$129,479.53

* Of seven men, deceased prior to 1938, and not covered by insurance.
** Including also $2,807 of losses incurred in "legal settlements" during 1930–1945, previously debited against administrative operating expenses of M.I.T.

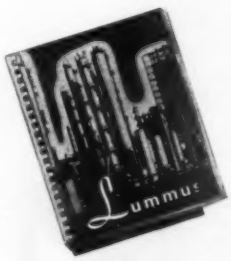


When the 10,000 barrel per day Thermofor Catalytic Cracking unit of the Tide Water Associated Oil Company, Bayonne, was shut down for inspection on January 7, it had been on stream 240 days.

Sprockets on elevator drive were reversed to balance wear. Elevator chains were shortened by removing two links. No major maintenance was necessary. Kiln linings and internals were in perfect condition. The total turnaround labor amounted to approximately 10,000 man hours.

Long initial runs are characteristic of Lummus plants. They reflect sound design, good engineering, careful construction . . . they presage the dependable operation repeatedly demonstrated in the 26 TCC units . . . 8 Polyform plants . . . 3 Houdry plants . . . 10 Alkylation units . . . 6 Isomerization units . . . 5-100 octane plants and many other Lummus contributions to the war time expansion of the petroleum refining industry.

If you have the problem of converting existing facilities to meet competition . . . if you are planning the installation of modern plants for the economical production of high octane motor gasoline, Lummus will be glad to co-operate with you in an unbiased study of the processes best suited to meet your refining and marketing conditions. Every Lummus study includes a thorough analysis and presentation of the economics of the proposed installation.



For further information on Lummus refinery surveys and construction, write for a copy of "Petroleum Refining Processes"; containing latest data, flow diagrams, photographs.

THE LUMMUS COMPANY

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600 South Michigan Avenue, Chicago 5, Ill.
Mellie Esperson Bldg., Houston 2, Texas
634 South Spring St., Los Angeles 14, Calif.
78 Mount Street, London, W. 1. England

Lummus

PETROLEUM REFINING PLANTS

THE INSTITUTE GAZETTE

(*Continued from page 300*)

Enrollment Trends

ALTHOUGH unprecedented opportunities exist in virtually all fields of science and engineering, a recent survey conducted by Professor B. Alden Thresher, '20, Director of Admissions, shows that interest in admission to the Institute centers largely in the fields in which wartime applications were prominent. At the same time, there is a paucity of applications for enrollment in a number of branches of science and engineering where the need for well-trained personnel is expected to be substantial.

Should the M.I.T. survey be typical of enrollment trends in technical institutes throughout the country, a probable dislocation of the nation's engineering educational program and engineering needs is foreseen. The present heavy interest exhibited in electrical, mechanical, and aeronautical engineering could result in training more men than would normally be employed in these three fields; at the same time, serious shortages may become apparent in the fields of geology, meteorology, food technology, biology, metallurgy, and business and engineering administration.

Undoubtedly the publicity which a number of wartime developments have received has had an important share in channeling interest into those phases of engineering which required large groups of personnel during the war. Service men in particular have been inclined to follow those fields of engineering in which they were engaged

(*Continued on page 306*)

Course	*Graduate School Applications*	*Total Undergraduate Applications*	*Pre-war Enrollment Total (Graduate and Undergraduate)*
	% of Total	*% of Total*	*% of Total*
Civil and Sanitary Eng....	5.4	4.7	3.4
Mechanical Engineering...	12.1	16.8	14.4
Metallurgy.....	4.9	1.4	5.2
Architecture and Planning	2.1	4.5	3.7
Chemistry.....	9.8	3.6	6.6
Electrical Engineering....	15.5	28.1	13.2
Biology and Food Technology.....	2.3	0.7	3.3
Physics.....	18.7	3.9	5.0
General.....	....	0.7	2.6
Sanitary.....	0.4	....	....
Chemical Engineering....	15.5	10.0	13.7
Geology.....	0.6	0.4	1.4
Naval Architecture.....	0.3*	1.4	6.9
Meteorology.....	2.0	0.6	3.7
Business and Engineering Administration.....	3.2	5.6	9.0
Aeronautical Engineering..	4.3	15.0	5.9
Building and Engineering Construction.....	0.1	2.1	0.7
Mathematics.....	2.8	0.5	1.2
	100.0	100.0	100.0
Number of Applications...	1121	1915	

*Exclusive of United States Navy officers

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MULTI-SPEED SURFACE COATING SYSTEM

WHS Model 4½ DB Worm Gear Speed Reducer
Ratio: 240 to 1

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The combination of a WHS Speed Reducer and a Reeves variable speed unit provides the necessary flexibility. Over 100 industries use WHS Speed Reducers,—"the First Speed Reducers in America to be Shipped from Stock." Have you our latest Catalog No. 145?

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BIG ...but not big enough

THE Bell System was big before the war, but it has to be bigger in the future. The needs of the nation have grown and it's our job to keep pace with those needs. We're spending close to two billion dollars in the next few years for expansion and improvement.

Size brings responsibilities and the Bell System aims to be big in more than size. The over-all policy is to give the best of service, at the lowest possible cost, to every one using the telephone.

BELL TELEPHONE SYSTEM

THE INSTITUTE GAZETTE

(*Continued from page 304*)

during the war, for a very definite correlation is evident between the course preferences of service men and their work in radar, radio communication, aviation, and other wartime activities.

It is not expected that in all cases entering freshmen will continue for four years in the courses for which they have applied for admission. Even making reasonable allowance for changes in courses which students often make in their second year, unmistakable trends are still apparent.

An additional feature disclosed by the survey is that there is a discrepancy between the preferences for courses at the graduate and undergraduate levels. In the graduate school, applications for enrollment in physics, meteorology, chemistry, and mathematics are proportionately greater by a considerable factor than applications for undergraduate courses in the same subjects. At the same time, graduate study in electrical engineering and aeronautical engineering makes less appeal than undergraduate study in these popular branches of engineering. Of the entering freshmen 33.3 per cent chose to follow electrical engineering, and 16.7 per cent aeronautical engineering, whereas for students entering with advanced (undergraduate) standing, 23.1 per cent have preferences for electrical engineering and 13.5 per cent for aeronautical engineering. In the graduate school, 15.5 per cent of the applications for admission state preference for electrical engineering, and 4.3 per cent of graduate applications are for study in aeronautical engineering.

The table shows the proportion of persons applying for admission for each of the Institute's courses, for the Graduate School, and for all undergraduates, compared with the distribution of pre-war registration as of November, 1940. Although it should be pointed out that the figures for admission applications may not reflect accurately the admissions which will be granted at the present time, it is believed that the figures do show the rather pronounced change in emphasis in engineering education resulting from the war.

Domestic Commerce Director

THE appointment of Brigadier General Albert J. Browning, '22, as director of the Office of Domestic Commerce, announced by Secretary of Commerce Henry A. Wallace on January 11, brings to an Institute Alumnus the responsibility for formulating the program and perfecting the organization by which the Department of Commerce will discharge its obligations in promoting and supporting the nation's industry and domestic commerce.

In his new post, General Browning will have under his direction the commodities and manufactured products sections of the Bureau of Foreign and Domestic Commerce, together with the sections responsible for wholesale and retail distribution, transportation, building construction, and the service industries.

(*Concluded on page 308*)

MARKET FORGE COMPANY
STANDARDIZED MATERIALS HANDLING EQUIPMENT

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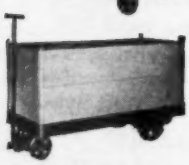
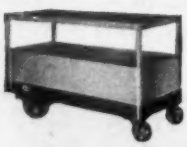
LOAD-CARRIER MANUAL NO. 1003MH





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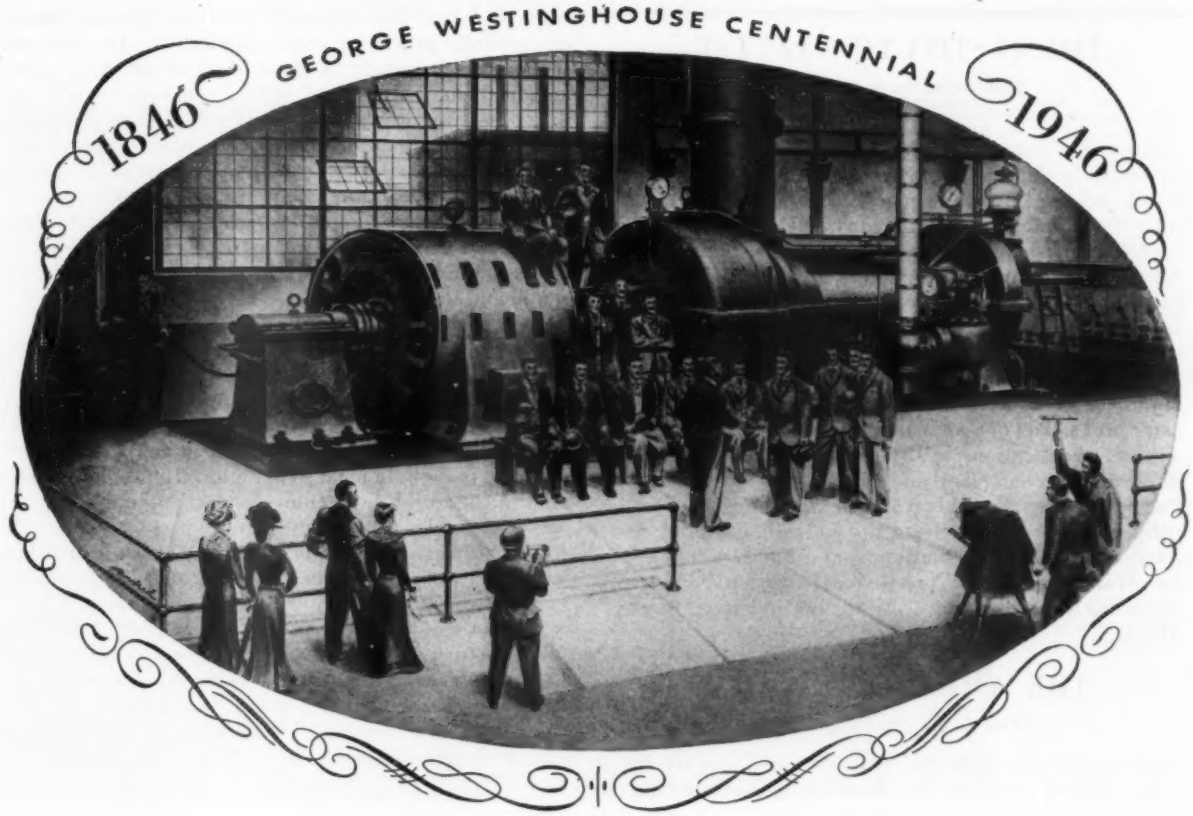
Market Forge standardized Load Carriers are the solution to even the most complicated and difficult handling problems. Heretofore, all trucks have been built so that construction changes could only be made at great expense or new trucks purchased. Now standardized interchangeable truck types serve all purposes.

George C. Glover '99 Nathaniel Warshaw '16 Leo M. Beckwith '35

MARKET FORGE COMPANY MATERIALS HANDLING DIVISION 99 GARVEY ST., EVERETT 49, MASS.



WHIRLING POWER

EARLY in life, George Westinghouse dreamed of a new and better source of power that would make obsolete the ponderous *reciprocating* steam engine of his day.

Even as a boy he had wrestled with the problem—securing his first patent on an engine of the *rotary type* when only 19 years old.

Years later, Westinghouse heard the exciting news about a *new type of rotary engine,* developed by Sir Charles Parsons in England. It was a steam turbine . . . using *jets of steam* to drive whirling blades.

Here was the answer to the problem that had fascinated Westinghouse since boyhood—and he promptly acquired the rights to manufacture the turbine in America.

The next few years were busy ones for George Westinghouse. With characteristic energy, he applied all his inventive genius in developing the still crude steam turbine into a *compact power source* for generating electricity.

Then, in 1900, Westinghouse installed a 2000-kilowatt steam turbine generator at Hartford, Connecticut—by far the largest then in existence.

It was the *first* practical central station turbine generator in America . . . a *new* application of whirling power that was to bring electricity to people all over the world.

Westinghouse
PLANTS IN 25 CITIES OFFICES EVERYWHERE

TODAY . . . America annually produces more than two billion kilowatt hours of electricity and more than three-fourths of the generating capacity in America is in steam turbine generators. Westinghouse manufactured a large share of these turbine generators—some developing more than 200,000 horsepower each. In 1946, more than a million horsepower of Westinghouse steam turbines will go into American power plants.

Tune in: JOHN CHARLES THOMAS—*Sunday, 2:30 pm, EST, NBC* • TED MALONE—*Monday through Friday, 11:45 am, EST, American Network*

THE INSTITUTE GAZETTE

(*Concluded from page 306*)

Since his graduation from the Institute, General Browning has had an extensive career in advertising and merchandising. He was general manager of the Peninsular Paint and Varnish Company in Detroit from 1931 to 1934, division and group merchandise manager of Montgomery Ward and Company in Chicago from 1934 to 1938, and president of the United Wall Paper Factories, Inc., in Chicago, for the next four years until he entered the Army.

During the war, General Browning served as director of purchases for the War Department from 1942 to 1944, assistant to chief of staff, communication zone, European Theater of Operations, in 1945 and, during the same year, director of procurement and disposal division, Western Pacific Theater. For this work, in which he was principally responsible for setting up and administering the Army's purchasing program and for formulation of policies for War Department procurement agencies, General Browning was recently awarded the Distinguished Service Medal.

THE AMERICAN FAMILY

(*Concluded from page 284*)

tinction to the European pattern, in which sibling rivalries "are directed inwards towards actual personal relationships inside the family group." [4] In the American family one typically gets along very well with one's brothers and sisters, and generally a great deal of affection exists among them. This ease of sibling relationships may explain the American's easy relationships with strangers, his ability as a good mixer. A European will commonly not speak to strangers, whereas to an American, a stranger is an immediate stimulus toward the establishment of friendly relations and an exchange of personal and family histories. The American, compared with the European, is a warm-hearted person. He is capable of a good deal of sentiment and affection.

In a sense, the American never really grows up; he never grows beyond the ideals which were patterned for him as a child; the male remains an overgrown boy, the female an overgrown girl. The American prolongs his youthful habits and ambitions into middle age. The emphasis in America is definitely upon youth. To remain youthful is itself an ideal to maintain. Hence, in no other land in the world do grandmothers and grandfathers try so consistently to resemble their grandchildren. The American, in short, is in many ways best described as an arrested adolescent who, therefore, has within him great potentialities for growth and development.

When the ethos of American culture shall swing away from the overweening emphasis on material achievement to a saner view of things, there is a good chance that the American character may yet serve as a guiding light to the rest of the world. And there is hope, for Americans are still in the growing-pains stage of their development.

[4] Mead, *op. cit.*, p. 111.

in addition to building **STEAM GENERATING UNITS** for all industrial requirements

Atmospheric tower for a refinery.

WE BUILD METAL MONSTERS LIKE THIS!

You've seen them in your travels about the country — the giant towers or columns rearing 100 or more feet skyward — that are the landmarks of the oil refining industry. Combustion Engineering has built hundreds of these and similar vessels in its boiler shops at Chattanooga and St. Louis. Many of them have gone into America's largest and most modern refineries, and many more — of various shapes, sizes and metal composition — are used in the chemical and process industries. Even larger pressure vessels than that pictured have been fabricated in C-E shops. One in particular—believed to be the largest single-piece shipment ever made by rail — weighed 490,000 pounds and was barely within railroad clearances.

But why should a company primarily engaged in the design and manufacture of boilers, fuel burning and related equipment be builders of vessels such as those described? The answer is simple enough. The facilities and operations used in the manufacture of boilers are identical to those required for the fabrication of all types of pressure vessels. And Combustion Engineering's facilities for boiler manufacture are the finest available. They have to be to permit the production of the most extensive line of boilers on the market in sizes ranging from 25 horsepower to the highest capacity boilers in service.

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C-E Combustion covers the steam generating requirements from 25 horsepower stoker-fired boilers to the largest power station units.

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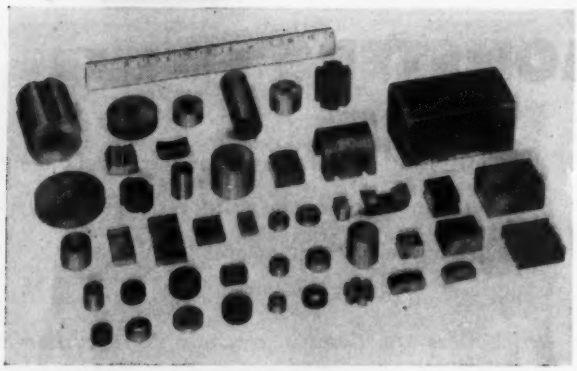

These Permanent Magnets are representative of some that have been designed for Motors, Generators, and allied equipment. If you have not used Permanent Magnets for these applications, consult us for engineering advice.

Write for Technical Bulletin—"Permanent Magnets for Industry," containing valuable data on design, production characteristics and applications of Permanent Magnets.

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Specialists in the Manufacture of
ALNICO PERMANENT MAGNETS

MAIL RETURNS

(Concluded from page 272)

Page 223: ". . . the crystallization of rock marks only one date in a much longer history of the earth." Any reader would suppose that rock crystallized once and for all time at one date in the earth's history — whereas rocks are crystallizing somewhere every day. I wrote about the crystallization of those particular rocks upon which the estimate of 1,500,000,000 years is based.

On the same page are two more errors in one paragraph: "My memory easily recalls the time when geologists accepted a story of the earth. . . ." Now, geologists *accept* the law of gravity, which they did not discover, but they didn't accept the story of the earth — they *knew* and *proved* "a story so complex that it must be long, so long that it covered a period which exceeded the time which astronomers of that day allowed for the formation of the whole solar system."

The *formation* of the solar system is taken to mean the early, dynamic period during which the planets of the solar system were formed out of the sun. This is not what I wrote. The geologists of that time knew a story of the earth which required more time than astronomers allowed for the entire history of the solar system from its formation to the present day.

On page 223, we read: "They [granites] could become part of our rock sequence in just two ways, by encroachment or by replacement." I did not write this; "encroachment" is a general word used to include all processes of granitic invasion. The correct words would be "by intrusion or by replacement."

On page 226, we read: "We can date the depths and heights that rim the Pacific. . . ." The word I wrote was "deeps" which is not at all the same thing as "depths."

Perhaps all this sounds small; it hurts me to write. Few of your readers will bother to read this essay, and it won't matter much if those few are misinformed by it. But some will read it and will care; and this letter is addressed to those. I appeal to those who are warmly interested in their earth to put the letter side by side with the essay and smooth out the wrinkles of inconsistency. And I thank the Editor for granting me the means to smooth them out.

Cambridge, Mass.

The Review regrets exceedingly that an unfortunate departure from its customary editorial procedure has given Professor Morris cause for the above letter. — Ed.

Solution

FROM WILLIAM SCHULTZ, JR.:

By now I presume you have been flooded with solutions to the apparently baffling problem mentioned by Mr. Langdon in "Mail Returns" in the January issue. No differential analyzer is needed, so we can save the wear and tear on this wonderful instrument. Since the fly is in the air for the same time that it takes the two cyclists to meet (one-half hour), the fly will travel 10 miles at the rate of 20 miles an hour.

Bloomfield Hills, Mich.

Rockets

FROM EDWARD F. BRADY, '41:

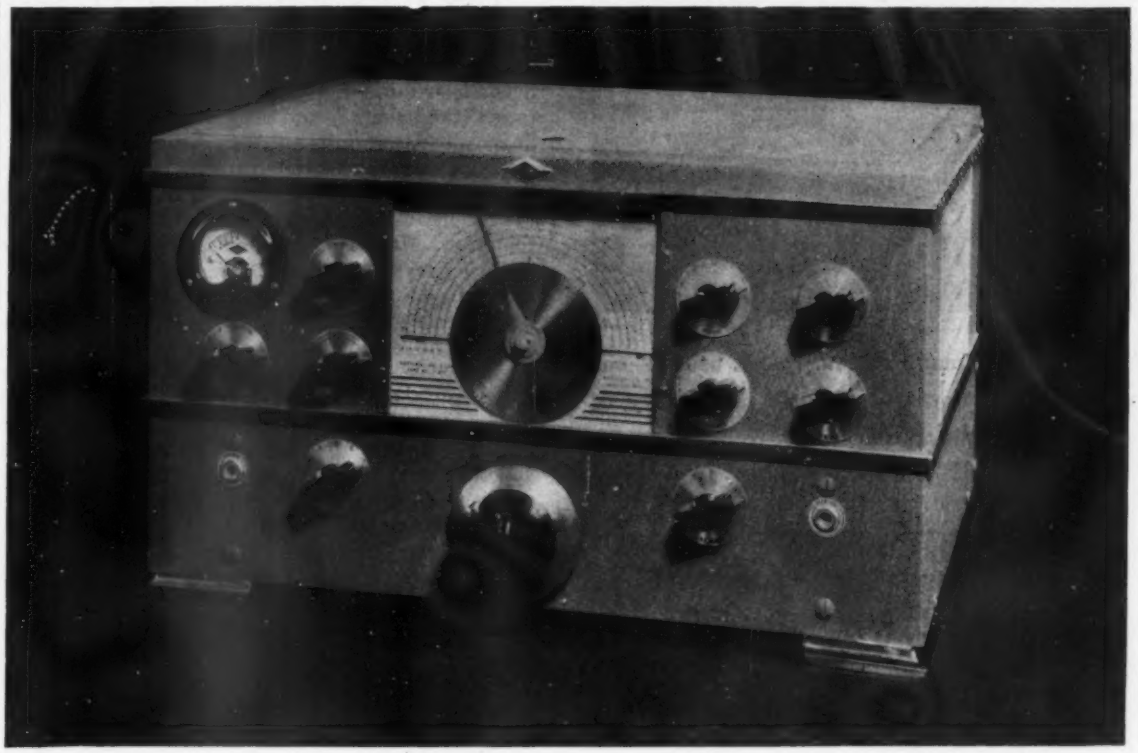
Could you tell me where I may obtain additional information about the rocket weapons described on page 158 of the January Review? Are there public reports available at this time published by any of the Allied governments?

Seattle, Wash.

Willy Ley, author of the article on rockets, replies:

So far only one rather comprehensive publication on German rocket developments has been issued, a lecture by Perring in London, which was delivered to the Royal Aero Club on November 10, 1945, and published by the club. This lecture, enlarged and annotated, with abstracts from the discussion that followed, will be reprinted by the Royal Aero Club in its *Bulletin*, presumably in the March issue.

Our Army and Navy departments have also promised comprehensive publications about German research (especially rocket development), but no publication date has been set so far. You will find the background for the whole development traced in my book, *Rockets;* and a short article on the rocket motor of the *Natter* and of the Me-163 has just been published in the January issue of *Aviation*.

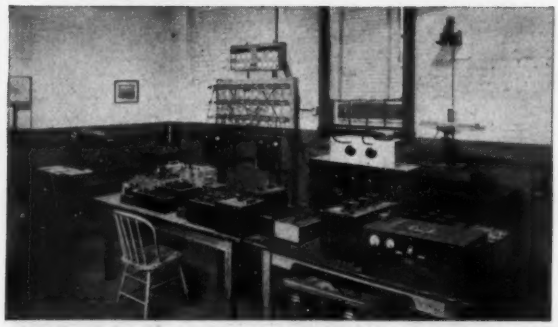


THE NC-2-40C

THIS superb new receiver reflects National's intensive receiver research during the war period. Many of the NC-2-40C's basic design features stem from the NC-200, but to them have been added circuit and construction details that set it apart as a performer. Stability and sensitivity are outstanding. A wide range crystal filter gives optimum selectivity under all conditions. The series-valve noise limiter, the AVC, beat oscillator, tone control and S-meter are among the many auxiliary circuits that contribute toward the all-around excellence of the NC-2-40C. See it at your dealer's.

NATIONAL COMPANY, INC.
MALDEN, MASSACHUSETTS, U.S.A.

MALDEN
MELROSE
★★★★



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Samson Cordage Works

Boston 10, Mass.

Herbert G. Pratt, '85, *Chairman of the Board*

Manufacturers of braided cords of all kinds, including sash cord, clothes line, trolley cord, signal cord, shade cord, Venetian blind cord, awning line, etc., also polished cotton twines and specialties.

SPOT CORD

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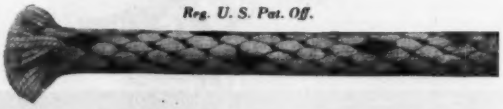


Our extra quality sash cord, distinguished at a glance by our trade-mark, the colored spots. Especially well known as the most durable material for hanging windows, for which use it has been specified by architects for more than half a century.

THE INDUSTRIAL WAY OF LIFE

(*Concluded from page 288*)

office buildings, apartment hotels, and tenements, but it floods over into the hinterland of the industrial dormitories (the suburbs) and the "rurban" retreats of the financially successful.

The future of industrial urbanism has become very uncertain. The reasons are cogent. The new air age marks the big city as the doomed target of the superbombers of tomorrow. Moreover, the great cities are slowing down in their growth rates, and the suburbs have become the recipients of the back-flow. The industrial city is not reproducing itself; its population deficit reaches at least 30 per cent in some instances and averages 15 per cent on the whole. As the community counterpart of the big enterprise, the big city finds itself enmeshed in endless inefficiencies and wastes of human resources. The massive patterns of the city — *e.g.*, its mammoth recreations, supermarkets, crowded tenements — grind the personal relations of industrial man exceedingly fine and thin, and they create, as two critics have recently said, "a fast rippling" but "shallow volume of life."[3] Here again one is confronted with the tragic disjunction of the inner and outer structures of industrialism.

[3] F. L. Wright and Baker Brownell, *Architecture and Modern Life* (New York: Harper and Brothers, 1937), p. 80.

ZENITH OR NADIR?

(*Continued from page 292*)

rent to penetration of the solid lithosphere. What of the hydrosphere, the great waters which compose two-thirds of the globe's surface?

Absence in water of oxygen in the state which may be respired by man was early and readily overcome through development of diving apparatus. Temperature in the oceans is not related exclusively to depth but is also governed by currents. In any event, its range from 27 to 88 degrees F. is such that only suitable clothing would be required to assure complete comfort. Light, totally lacking below about 3,000 feet of ocean depth, is readily provided. But — and here we find the secret of the ocean's aloofness — water is so many times more dense than air that pressure changes are correspondingly exaggerated. We noted an air-pressure differential of but four pounds per square inch between sea level and 10,000 feet of altitude. At this distance below the surface of the sea, water pressure which was zero at the surface has increased to more than two tons per square inch!

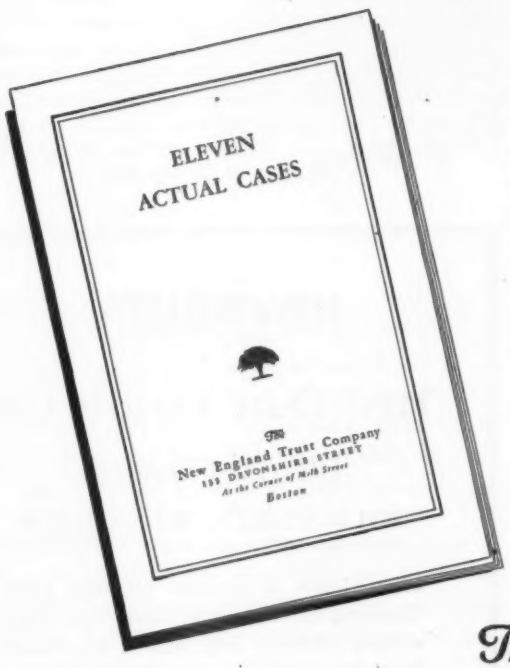
For reasons which will be given it has been necessary in most forms of diving apparatus to maintain an internal pressure approximately equal to that of the surrounding water. The simple diving helmet which rests on the shoulders of the user is open at the bottom; to prevent water from entering by merely compressing the air within the helmet, the pressure of this air must be increased as the diver descends. The next development, a helmet joined at the neck to a flexible but air- and watertight suit, allows the diver to control his buoyancy by increasing or diminishing the flow of air, so that a greater or lesser amount remains within the suit.

The obvious development of an inflexible suit or chamber provided with some other means of buoyancy control has been limited by the difficulty of designing long and

(*Continued on page 314*)

Eleven Practical Illustrations of Successful Estate Planning

The booklet here illustrated discusses the cases of eleven actual property owners who, through revising their estate plans, were able to provide greater security for their families and, in many instances, to achieve notable savings in taxes.



Since the average individual cannot be expected to be aware of all the problems involved in planning the settlement and distribution of an estate, we believe you may find this booklet interesting and helpful. We shall be glad to send it to you, on request.

The

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At the Corner of Milk Street

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SURFACE PYROMETERS
FOR EVERY PURPOSE

The correct temperature of roll surfaces, masses of plastic materials and of mold cavities is vitally important in many processing industries. The routine use of a dependable surface pyrometer takes the guess-work out of such temperature determination. The Cambridge Surface Pyrometer is the ideal shop instrument for all these applications. It is accurate, rugged, quick acting and easy to use. The Roll Model is for checking surface temperature of still or moving rolls. The Needle Model is for within-the-mass temperature and the Mold Model is for checking mold cavities.

Send for bulletin 194CP

CAMBRIDGE
ROLL • NEEDLE • MOLD
PYROMETERS

CAMBRIDGE INSTRUMENT CO., INC.
3707 Grand Central Terminal, New York 17, New York

ZENITH OR NADIR?

(*Continued from page 312*)

flexible air hoses with walls sufficiently rigid to withstand crushing water pressure when air pressure within the hose is much lower. This obstacle has, with some degree of success, been circumvented by eliminating the air hose and providing in its stead an air regeneration device contained within the diving apparatus. This device depends upon absorption of expired carbon dioxide in caustic soda and its replacement with oxygen from tanks of the compressed gas. Nitrogen, the inactive gas which composes about four-fifths of the air, is recirculated indefinitely.

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(*Continued on page 316*)

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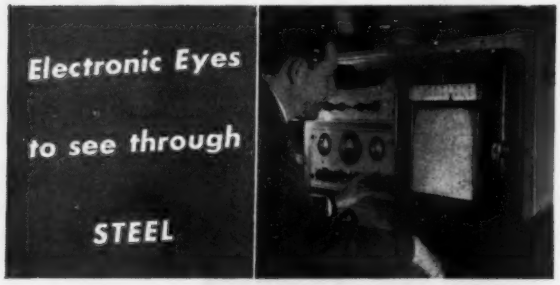

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IS STILL A CRAFT

ZENITH OR NADIR?

(*Continued from page 314*)

markedly, a certain amount of inhaled air goes into solution in the blood, in this way being transported quickly to all the body fluids and tissues. Oxygen thus dissolved is utilized for tissue respiration, but nitrogen remains in solution. Although this in itself does no harm, when pressures decrease the process is reversed; and if the change is too rapid for the dissolved nitrogen to be returned to the lungs and there expired, the body fluids effervesce, giving off bubbles of nitrogen which produce the dangerous, even fatal, condition called bends. Certain tissues, such as the fibrous tissue at the joints, take up nitrogen slowly but are correspondingly retarded in releasing it; hence it is here that symptoms are most likely to appear.

Clearly the solution of this difficulty is slow decompression or return to normal pressures; such time criteria have been worked out for the various depths and times of immersion. For example, after working an hour at 48 feet, the diver may return to the surface within 1½ minutes and may do this as a continuous ascent. In contrast, after working but 10 minutes at 276 feet, the diver must ascend in not less than 76 minutes, stopping for prescribed intervals every 10 feet, the last stop being 20 minutes at 10 feet below the surface. The essential impracticality of diving operations at great depths is patent in view of these 76 minutes as minimal decompressing time, plus whatever time is required for descent (this, however, being ideally as short as possible), to achieve but 10 minutes of working time. An interesting feature of the decompression formula is the requirement that stops be longer as the diver nears the surface. Regarding this in terms of pressure readings of the air gauge, pressures over 30 pounds per square inch may be allowed to drop at the rate of 1 pound a minute. In the final range of 10 to zero pounds the safe rate of decrease is but 1 pound in 5 minutes.

Elihu Thomson's universal genius found an application in the problems of diving. Knowing that pure oxygen cannot be breathed at the increased pressures involved, he proposed a synthetic air in which helium replaces nitrogen. In addition to being 40 per cent less soluble than nitrogen in the body fluids, helium, with a molecular weight only one-seventh as great, has a considerably higher diffusion rate and is therefore released more readily through the lungs.

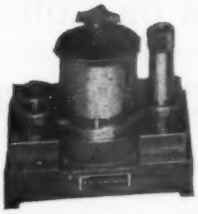
A final problem of diving is the increased toxicity of carbon dioxide at high pressures, making large volumes of air necessary at greater depths to assure adequate ventilation. For example, at the surface 1½ cubic feet of air a minute is ample for the diver; whereas at 210 feet, 11 cubic feet a minute, on the basis of air at atmospheric pressure, is required.

Thus are highlighted the reasons why man has abhorred the depths of earth and sea.

But, it may be asked, what of the natural deep holes? What of the caves, sink holes, chasms, abysses — the bottomless pits? For, in many regions, local lore has it that certain of these dark and forbidding openings in the earth are indeed without bottom. Thus anything of which the compass exceeds man's comprehension is for him without beginning and without end.

First, all natural pits have bottoms. An intrepid and skilled speleologist will inevitably reach or sound a lower limit to any explored cave and usually, in terms of the

(*Continued on page 318*)

From  a single tool or part . . .

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ZENITH OR NADIR?

(*Continued from page 316*)

depths we have been considering, at a level not far below the mouth. This is axiomatic, because all such passages are present or former water courses; hence they must discharge no lower than the level of the water table.

And now will appear why natural abysses have been ignored in this consideration of true penetration into the earth. Abysses are mountain phenomena; if a hole of any depth is to terminate above the water table, it must originate at a high altitude. For instance, the deepest known abyss in France, the Gouffre Martel in the Pyrenees, as measured by its discoverer, the fearless Norbert Casteret, was found to be 1,566 feet in depth. But its upper opening, high on a mountain slope, is at the altitude of 9,225 feet. Hence even this titanic gulf does not approach sea level. This being true of all natural abysses, they are immune to the blistering, increasing heat which seeks to drive man from the pits he has the temerity to drive below the earth. Caves are, in fact, delightfully cool and isothermic places, those in the United States ranging from 48 to 56 degrees F. throughout the year, and varying but 4 degrees throughout the year in a typical chamber.

Man is the only organism possessed of scientific curiosity and desire for material gain which impel him deliberately to fare beyond the limits of height and depth within which he prospers. Other living forms, devoid of such instincts, have developed adaptive powers which permit them not only to travel to, but to remain and flourish at, extremely high and low levels. Certain mammals thrive at altitudes over 16,000 feet; birds have been

(*Concluded on page 320*)

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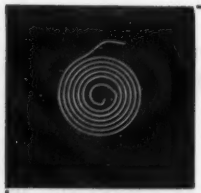

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ZENITH OR NADIR?

(Concluded from page 318)

observed to live at 27,000 feet and to attain a height 2,000 feet higher than that in migratory passages. The whale, a mammalian form, readily dives a mile below the surface of the sea; deep-sea fish occur to 17,000 feet; and other forms of marine life, largely microscopic, have been found as low as 23,000 feet. In contrast, life in the solid lithosphere ceases a short distance below the surface.

Recall that we delimited our consideration to those regions where man has insinuated his own personal presence. His knowledge vastly exceeds these narrow confines; for have not the telescope, spectroscope, and other instruments of the astronomer minutely inspected stars trillions of miles distant from our earth? In the earth itself deep oil wells are sunk to depths of 15,000 feet, permitting sampling of the rock at these levels and allowing studies of temperature phenomena. Ocean deeps, once measured only with the limited sounding lead and line and hence thought to be bottomless in some locations, are now readily and accurately surveyed with the fathometer. This instrument utilizes an ultrasonic impulse, transmitted downward from a moving ship and received as an "echo" from the bottom of the sea. Since the interval between transmission and reception is a measure of the distance traveled by the impulse, a continuous automatic record of these intervals traces an exact contour of the bottom over which the surveying vessel passes.

Fathometer studies reveal that from any point of view ocean depths exceed land heights. The great Mindanao Deep off the Philippine Islands measures 35,400 feet below mean sea level; with this compare the 29,141-foot height of Mount Everest. Furthermore, the average of ocean depths, 12,500 feet, is more than five times greater than the average of land altitudes. The ocean floor bears what is really the greatest mountain in the world, the sister peaks of Mauna Kea and Mauna Loa on the island of Hawaii. Detached from any continent, the slopes of this mountain on reaching the sea continue downward and flatten out only on meeting the ocean floor, 18,000 feet below sea level. Adding this distance to their terrestrial height of 13,750 feet, we see that the Maunas, measured from the level floor of the Pacific, are 2,500 feet taller than is towering Everest measured from sea level. Hence Ocean is mightier than Land, in area and in contour extremes.

Where lies the future in penetration of heights and depths? Scientific progress is necessarily accelerated by promise of economic reward. Entry into the stratosphere has found practical application in airplane flight in this zone of equable meteorological conditions and minimal air resistance. Mountain-climbing techniques will continue to be developed by scientists and sportsmen, but if some objective such as a high-level deposit of desired ore should be discovered, we may look for perfection of means whereby human beings may not only reach, but may live and work at high altitudes. Mines and oil wells can be carried as deep as the desired veins exist, provided the resultant yield is sufficient to pay for the vastly increased cost of operations at lower levels. The floor of the ocean has been mapped, and if sound economic reason evolves for descent below the limits to date, diving technologists will discover the means.

Whether zenith or nadir will be attained first depends on where economically governed technology is led.

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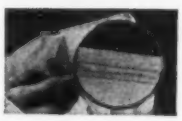

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THE CHANNEL TUNNEL

(*Concluded from page 294*)

whether the estimated expense of £60,000,000 would be well spent. Since the war budget at that time was £6,000,000 daily, there could be little doubt about that point. The sudden German campaign against the lowlands and France relieved the council from making a decision.

In the light of Marshal Foch's statement, however, one can only wonder what would have happened if the MacDonald government had agreed to the tunnel in 1924. It would have been in operation in 1930 or 1931. If so, England might have been able to relieve its forces in Belgium and might have been able to hold a European bridgehead all through the war. Dunkerque would not have happened. At the very worst, the tunnel would have been useless to both sides.

Operation Pluto proves what good there was in the old and always rejected idea, and the success of British operations in general may tend to make future British governments more self-confident and consequently more lenient toward the idea of the Channel tunnel.

Present Prospects

The tunnel may still be built, and there are many points in its favor. As an engineering project the tunnel is not only possible but actually easily accomplished. It is merely a question of magnitude, not a problem of difficulty. As a financial project the tunnel is likely to be a bonanza. Even the most conservative estimates admit that a Channel tunnel railroad could show a greater net profit than any other railroad in the world. From the military point of view the tunnel is apt to be an asset; at worst it cannot be a liability.

If such a tunnel were built, how would it look? It would be constructed for electric trains only in order to facilitate ventilation. Automobiles could be put on special railroad cars, coupled to the train, to be transported through the tunnel in about the same manner as a ferryboat carries automobiles across a river. The tunnel would probably consist of two parallel tunnels of circular cross section, with a recessed gallery for traffic control, watchmen, and repairmen, with interconnections between the two tunnels every 500 yards. Naturally all the safety devices invented for and in use in subways could be employed.

The train trip through the tunnel would take about 30 minutes, whereas in the very best of sailing weather (which is rare indeed over there) the boat trip across the Channel takes about three times as long. The main saving, however, would not be that brought about by the higher speed of the train. What happens at present is this: The train from London to the coast takes about an hour, you then climb out of the train, wind your way around piles of coal and other obstacles and find the Channel boat, which sails after some 30 minutes' delay, provided the weather is not too bad. If the weather is bad, you wait for it to improve. At the other side you walk off the boat — some people are too seasick to do that well — and board another train which departs after half an hour's delay. The tunnel train would go through with little if any delay at either end, saving more than an hour of embarkation and debarkation time. The tunnel train could have sleepers for those making long journeys.

Possible postwar aviation may spoil this argument as far as passenger traffic is concerned; but very heavy freight, or bulk freight, is not going to fly.

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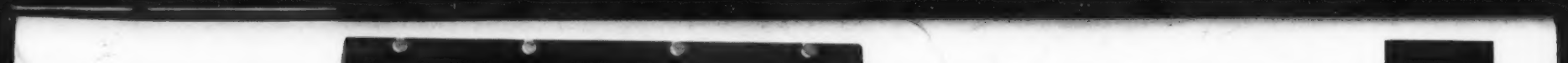
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